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BULLETINS

FROM

ONTARIO AGRICULTURAL COLLEGE
ONTARIO DEPARTMENT OF AGRICULTURE
HORTICULTURAL EXPERIMENTAL STATION
AND
WESTERN ONTARIO EXPERIMENTAL FARM

Nos. 333 to 350

ONTARIO

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TORONTO
1930

BULLETINS

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ONTARIO DEPARTMENT OF AGRICULTURE
HORTICULTURAL EXPERIMENTAL STATION
AND WESTERN ONTARIO EXPERIMENTAL FARM

DECEMBER, 1927, TO JANUARY, 1930

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Bulletin 333 December, 1927

Ontario Department of Agriculture

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TOBACCO CULTURE

INTRODUCTION

The material in this bulletin has been gathered together to serve as a guide for the beginner rather than for the more experienced. Information has been gleaned from various sources but much of it from those who have had many years of successful experience in the growing of tobacco. Seasons, soils and general conditions are so variable that it is extremely difficult to cover all circumstances in a brief statement.

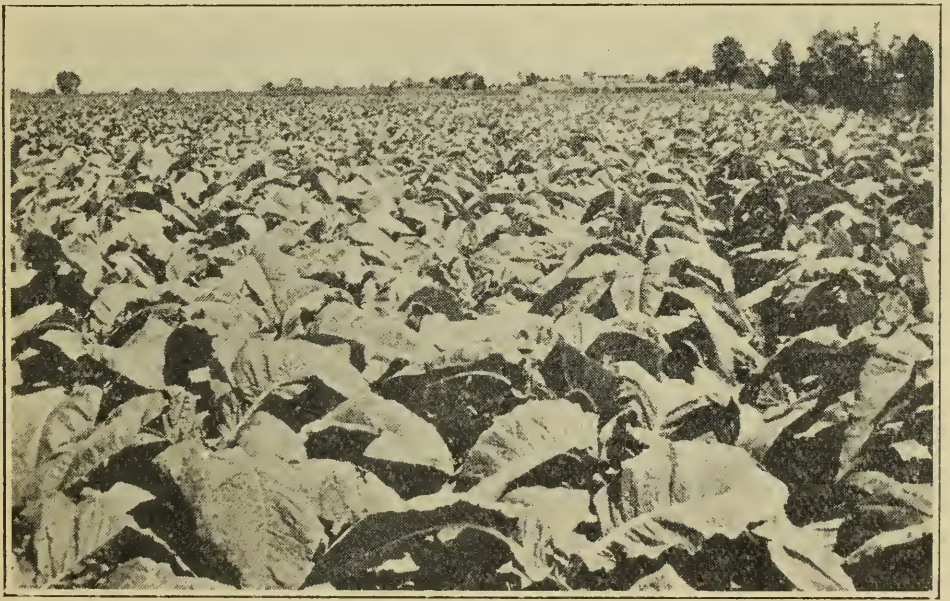

Fig. 1.—A field of Broadleaf Burley Tobacco.

The production of tobacco on a commercial basis had its origin among the tribes of Indians in Southern Ontario, who grew and bartered it with the more northerly tribes; the early white settlers produced and shipped it to the eastern Canadian markets. Production gradually decreased and finally was discontinued for many years.

About 1900, the growing of tobacco was undertaken again and markets have been gradually developed until Ontario produced tobaccos are in world wide competition in Great Britain and the demand, provided the quality is good, is steadily becoming stronger; during 1922 the value of our exports was $259,629. whereas in 1927 the value had increased to $2,726,347.

Large quantities of bright tobaccos are imported for home consumption; in 1922 this was worth $9,947,903. but in 1927 these imports had decreased to $7,602,013. The increased production of the Flue-cured or bright types accounted for this decrease.

The industry had developed slowly previous to 1915 but, due to the impetus given during the war years, the acreage rapidly increased until 19,621 acres were grown in 1920. The slump in prices affected production and 6,663 acres only were grown in 1921 but with the improvement in the markets in 1926 there were 23,493 acres. During 1927, the territory was widened taking in several new districts and in the older and recognized tobacco areas planting was on a considerably larger scale.

The phenomenal increase in exports during the past five years, a satisfactory demand, the British preference of two shillings two pence per pound upon Empire produced tobacco, the diminished import and a steadily increasing population in Canada are the factors directly responsible for the increased acreages throughout southern Ontario.

Since the early settlers produced tobacco upon the virgin soils and the changes in the methods of farming have taken form, sufficient information has been gathered practically and experimentally regarding climate, soils, types of tobacco and methods of growing and handling and so successfully applied that yields are large and the quality is such as to permit successful competition. Therefore reasonable profits from the growing of tobacco are expected.

The profits from any form of agriculture are largely dependent upon the amount of judgment, ability and energy expended by the farmer. Crops giving large returns per acre lend themselves to speculation in production. Very often, too large areas are planted, resulting in low yields of medium or inferior grades of product commanding unsatisfactory prices. Maximum yields of the highest quality at a minimum cost should be the aim of every tobacco grower; large net profits are not always had from large acreages but from the largest number of acres of crop handled properly in every detail. The new grower without experience would do well to start modestly. The tobacco crop demands a great deal of labor and attention and, if not provided, a substantial profit may very quickly be transformed to a loss. Tobacco is not a cheap crop to produce and is sold on a quality basis.

CLIMATE

Throughout the Province of Ontario, there are large areas of land suitable for the production of tobacco. Climatic conditions, however, govern. Wherever corn has been successfully grown for the production of seed, tobacco has done equally well. The length of the growing season is one of the principal considerations because tobacco is a crop that grows very rapidly, providing all conditions are favorable; the seed bed must be in excellent shape and warm.

The date of the occurrence of the last frost during the Spring is important but of more importance is the date of the first killing frost in the Fall. In the southerly districts of Ontario, occasionally tobacco is frozen, consequently, unless the length of time for growth is comparable to that in the Chatham-Windsor region, considerable experimental work with very small areas should be carried out before much outlay is made.

Generally the counties of Southwestern Ontario have the longest growing season, the longest period without killing frost and the most sunshine but this is not proof that tobacco cannot be grown successfully in other parts of Ontario because altitude and bodies of water have an effect.

FROST DATES IN ONTARIO

Station	Mean Date Last Frost (Spring	Mean Date First Frost (Fall)	Days Without Frost
Windsor	Apr. 29th	October 17th	171
Chatham	May 10th	October 6th	149
Welland	May 8th	October 7th	152
London	May 21st	September 25th	127
Brantford	May 17th	September 23rd	129
Stratford	May 20th	September 25th	128
Kingston	May 6th	October 3rd	150
Ottawa	May 6th	October 1st	148
Guelph	May 17th	September 26th	132
Goderich	May 15th	October 12th	150

MARKETING TOBACCO

The major part of the tobacco is sold before Christmas while it is in the curing barns and before it is stripped. Payments in all cases are now made when the crop is delivered whether it be to a warehouse or car door.

Purchase is usually made on a "flat price" for the "crop run" but quality is the determining factor; the price fluctuates according to the quality of each individual crop. There is, however, a general valuation of tobacco of good quality, which serves as a guide.

The "contract" system is not very popular. Under this arrangement a grower in the Spring agrees to sell his crop to a particular buyer and a range in price, according to quality, is agreed upon. The contract, of necessity, must permit of a wide range between the poorest and the best and too often leaves opportunity for considerable discussion as to the grade of the tobacco.

There is a co-operative company operating in the district but latterly it has been paying a flat price on delivery and thus operating much as a private company.

Fluctuations in price have been violent and were responsible for the increase and decrease in acreage. Prices considerably above or below the average price have similar ultimate effects upon production. The very high price stimulates large acreages and too much tobacco is thrown upon the market and invariably causes a slump in price which, in turn, is responsible for decreased planting. World wide growing and competition in the British markets from countries far apart, where operating charges are widely different, make the stabilization of the market extremely difficult.

Growers would do well to consider carefully the acreage they can handle well each and every year and fluctuate but little from that acreage. If such a system were followed, there would be less low grade tobacco, higher average yields, a considerably higher average quality with a much better chance of securing the highest market price.

There is a substantial preference on Empire grown tobaccos on the British market. Foreign tobaccos are taxed approximately $2.08 per pound and that from the Empire $1.56 per pound upon entering Great Britain. This difference must go either to the British consumer, the dealer, or the Empire grower. If it is divided equitably among all three it should be a great advantage to Ontario grown tobacco.

The advantage given, however, is not a permit to unload any class or grade of tobacco; Britishers are shrewd traders and demand products of high quality and are prepared to pay a fair price upon the open market, but they are not bidding for low grade material. If such cannot be shipped to Great Britain profitably, it then must be sold on continental or on the home markets but for a price at which it cannot be profitably produced.

The expansion of the tobacco industry depends very largely upon exports and, under such a condition, quality is the first consideration from the producer's as well as the buyer's standpoint. Canadian tobacco has created a favorable impression in Great Britain but this popularity cannot be continued unless the growers, packers and exporters join to protect the trade by growing and guaranteeing every pound of tobacco exported.

From the figures which follow, the very large increase in exports and the gradual decrease in imports can be readily noted:

EXPORTS OF TOBACCO

	1922 Lbs.	1923 Lbs.	1924 Lbs.	1925 Lbs.	1926 Lbs.	1927 Lbs.
Tobacco Unmanufactured	471,991	1,100,007	2,055,337	3,531,422	2,860,413	6,330,972
Cigars	539	987	2,833	1,799	1,455	837
Cigarettes	24,205	44,703	96,094	92,848	54,258	53,482
Plug and Twist	1,083	5	11,113	9,262	7,112	7,359
Stems and Cuttings	741,000	535,800	404,300	777,400	409,700	483,900
All other Tobacco	12,075	18,292	32,735	45,176	76,641	220,081
Total	1,250,893	1,799,794	2,602,412	4,457,907	3,409,579	7,096,631

VALUE OF TOBACCO EXPORTS

	1922 $	1923 $	1924 $	1925 $	1926 $	1927 $
Tobacco Unmanufactured	175,826	297,923	375,582	733,166	1,045,673	2,569,300
Cigars	2,399	3,220	9,832	5,757	4,962	3,388
Cigarettes	24,743	25,798	72,667	48,649	26,109	18,243
Plug and Twist	1,169	13	6,417	6,283	3,895	4,531
Stems and Cutting	37,975	12,902	17,121	20,220	8,558	12,003
All other Tobacco	17,517	27,258	44,222	65,294	91,343	118,882
Total	259,629	367,114	525,841	879,369	1,180,540	2,726,347

IMPORTS OF TOBACCO

	1922 Lbs.	1923 Lbs.	1924 Lbs.	1925 Lbs.	1926 Lbs.	1927 Lbs.
Tobacco Unm'fd	20,870,509	14,548,694	15,941,339	13,712,885	14,943,864	17,446,774
Cigars	15,081	18,915	17,035	16,621	18,453	16,572
Cigarettes	27,136	36,127	31,880	42,115	50,896	45,622
Snuff	4,026	6,274	7,166	5,562	6,759	6,028
Tobacco Cut	359,721	393,631	389,385	322,366	332,948	343,513
All other Manufactures of Tobacco	84,196	64,766	75,394	72,129	74,074	66,678
Total Tobacco	21,360,669	15,068,407	16,462,199	14,171,678	15,426,994	17,925,187

VALUE OF TOBACCO IMPORTS

	1922 $	1923 $	1924 $	1925 $	1926 $	1927 $
Tobacco Unman'fd	8,867,469	5,854,405	7,166,989	5,944,699	6,311,782	6,473,167
Cigars	125,266	133,715	119,512	116,723	133,902	122,778
Cigarettes	110,261	120,492	120,834	151,452	192,269	171,591
Snuff	6,655	10,277	13,216	10,520	14,454	12,366
Tobacco Cut	699,262	841,407	830,658	644,221	711,603	674,515
All other manufactures of Tobacco	138,990	129,165	153,562	146,924	161,466	147,596
Total Values	9,947,903	7,089,461	8,404,771	7,014,539	7,525,476	7,602,013

AREAS OF TOBACCO GROWN IN ONTARIO

	acres		acres
1900	3,144	1919	9,226
1910	7,017	1920	19,621
1911	13,591	1921	6,663
1913	6,000	1922	9,189
1914	5,000	1923	8,630
1915	4,500	1924	13,273
1916	2,958	1925	18,261
1917	2,930	1926	23,493
1918	6,500	1927—Estimated	33,650

A careful study of the areas grown and the prices paid during the past twenty-five years proves conclusively that tobacco growing is quite speculative and does not become particularly attractive until the price for Burley reaches and remains around 18 to 25 cents per pound.

TYPES AND VARIETIES OF TOBACCO

In the three main groups of tobacco, which are grown in Ontario, there are a few outstanding varieties which, up to the present, have proved most satisfactory. No doubt there are other varieties which may, in time, become popular or which may be developed to meet the requirements within the province. In the meantime, the tobacco grower who contemplates growing any of the three types mentioned is advised to stay within the limits of the varieties in which experience has been already gained.

BURLEY TOBACCO:

There are two main classes of Burley tobacco, namely, Broadleaf Burley and Stand-up Burley.

Broadleaf Burley: The Broadleaf Burley produces a broad, thick leaf, which droops very decidedly. The leaf is inclined to be a little more coarse in texture than the Stand-up Burley grown under similar conditions. Broadleaf Burley is usually grown on lighter types of Burley soils. It yields most heavily of all the Burleys and, when well grown, cures a bright attractive leaf.

Stand-up Burley: This plant differs from the Broadleaf in that its leaves are more narrow and inclined to be more strap-shaped than in the Broadleaf type. The plants also grow more erect and, from this character, the name of the plant is derived.

Varieties—Station Stand-up, Resistant Stand-up and Stoner's Stand-up.

Resistant Burley: There are strains of tobacco of the Burley type, which have been developed to grow on soils infested with root-rot organisms. Where Burley tobacco has to be grown on diseased soils, it is recommended that some of the resistant strains be secured but other than for this purpose it is not advised because they are lower yielders.

GREEN RIVER TOBACCO:

Green River tobacco is the term applied to common types of Dark tobacco, which are grown in Ontario as air-cured and fire-cured tobaccos.

The most popular varieties of this type are the following:

Yellow Pryor is a tobacco of the broadleaf type and produces rather coarse, drooping leaves. In some sections, it appears to require a little longer growing time, in order to cure equally with the other two varieties.

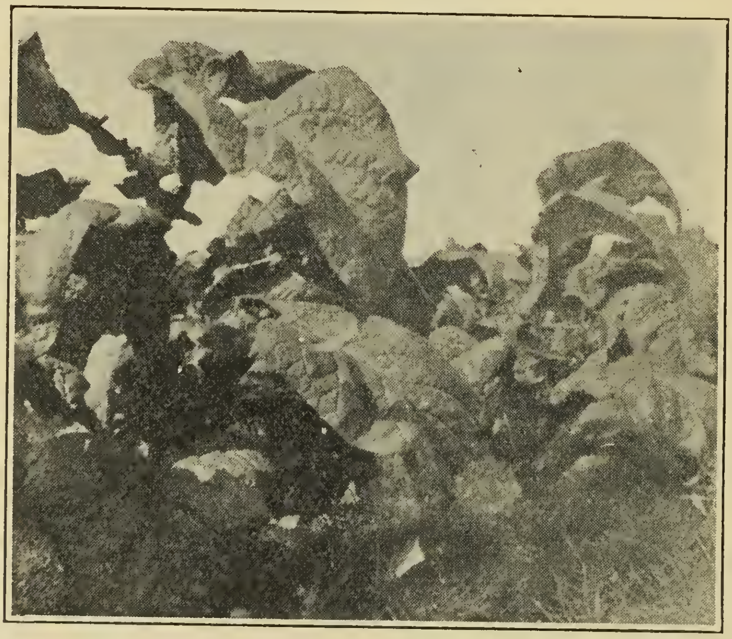

Fig. 2.—Plants of the Green River group.

Greenwood is more of a stand-up type and produces fairly long and rather broad leaves. It is considered by many growers to be a leading type of dark tobacco.

Little Hill is also a tobacco of the stand-up type though less so than the Greenwood. Its leaves are not quite so large as those of the Greenwood but, when cured, it gives a good quality of leaf.

All three of the above varieties appear to yield within a comparatively narrow range of each other.

FLUE-CURED TOBACCO:

Warne Leaf is the most widely grown and recommended type. Hickory Pryor is another variety which is grown to quite an extent. Both types are of a broadleaf nature, mature early and cure satisfactorily. The Warne probably yields a little more per acre under average Ontario conditions. The Hickory Pryor, though more susceptible to disease than the Warne, is likely to prove a better variety for soils that may be inclined to be somewhat heavy in type or are too fertile for Warne.

TOBACCO SOILS

* The section on Soils was contributed by G. H. Ruhnke, of the Department of Chemistry, Ontario Agricultural College, Guelph.

It has long been recognized wherever tobacco has been grown that the soil is a most important factor in determining the quality of leaf that is produced. The kind of soil on which the tobacco is grown determines in a large way the colour, fineness of texture, body and such other properties as go to make for a high or low quality leaf. Hence it is of necessity that the prospective tobacco grower choose with care the soil on which he proposes to grow this most exacting crop.

In any discussion of tobacco soils it must be kept in mind that there are three main classes or types of tobacco commonly grown in Ontario, viz., Flue-cured, White Burley and Dark tobaccos. These types differ considerably as to soil requirements which make it essential that they be considered separately in any discussion of soil types no matter how general.

Drainage of First Importance

The first and most important requirement of all tobacco soils is that they should be adequately drained, both in surface and internal drainage. Tobacco is one crop that does not tolerate "wet feet" and will not do well where deficient drainage exists. Poor internal drainage means a waterlogged subsoil, which does not permit normal vigorous development of the root system of plants. Without a well developed root system it is not possible to have a normal well developed plant.

The best indication of the nature of the internal or subsoil drainage is found in the color of the soil *below* the surface or usual plow depth. The character of the lower layers in all soils is of as much importance as the character of the surface, in a great many, of more importance than the surface. There are plenty of cases where the nature of the subsoil determines the productivity of the land.

How to interpret Soil Colors

A dark brown, or black surface soil indicates a larger amount of organic matter present than in light colored soils. In general it also indicates a high content of nitrogen, an excess of which tends to produce a dark colored, heavy, late maturing tobacco.

In the layers below plow depth, soil color is an indication of the degree of aeration or ventilation and the condition of the natural drainage.

A yellow or reddish brown color in the subsurface and subsoil means that it is well drained and has good ventilation or plenty of air—an essential condition in a productive soil.

A gray, slaty, drab or blue color, indicates improper aeration (an unhealthy condition) and deficient drainage. Sometimes these gray, drab and blue colors are streaked or mottled with rusty red or brown, indicating that the soils are about intermediate between the well drained, well ventilated soils and the waterlogged and poorly drained soils.

Excess moisture in the soil makes the land cold and late in the spring, retards the planting time and shortens the growing season. It is better to choose land naturally well drained, than to choose poorly drained land and try to remedy such a deficiency. Good natural drainage is a first essential.

FLUE-CURED TOBACCO SOIL

Flue-cured tobacco is generally considered to be the most exacting type of tobacco in its soil requirements. Experienced growers are most discriminating in their choice of land for the production of a high quality flue-cured leaf.

The soil that is most widely used for this purpose may be described as a medium fine, yellow brown sand, 8 to 10 inches in depth of surface, underlaid with a bright, golden-yellow, fine sand to a depth of from 1 to 2 feet, where it changes to a red or reddish brown, clayey sand layer, varying from a few inches to 1 foot in thickness. This is the true soil. Immediately below this red somewhat sticky layer is the "substratum" or original material from which the soil has been derived. It usually consists of grey bedded sands or sands and gravel interbedded or in some cases may even be clay.

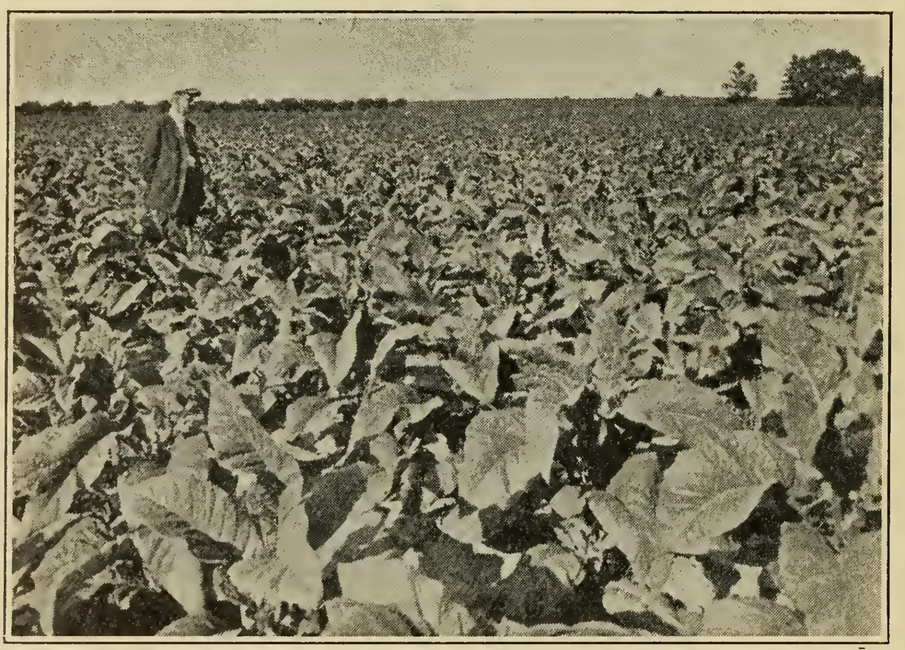

Fig. 3.—A 40-acre field of Warne tobacco.

The typical flue tobacco soils of the Leamington and Lynedoch districts conform to this description.

It is well to note, that the presence of the *red clayey sand* layer is of vital importance in controlling the moisture supply and lessening leaching of this type of soil. An examination of the surface above will not reveal its presence or absence; an auger or a spade should be used to examine the lower layers. In our sandy soils occurring in Southern Ontario, there are several associated types with medium find sand surface soils, but with this important red clayey layer either totally absent or only very slightly developed. These sandy soils are drouthy, do not conserve moisture, leach badly and are frequently subject to drifting or blowing. They should be avoided by the prospective flue tobacco grower.

BURLEY TOBACCO SOIL

The Burley tobacco can be grown on a variety of soils and still retain a fair quality of leaf. The usual soil types are sandy loams, loams and gravelly loams, well supplied with organic matter and of higher fertility than the soil preferred for flue tobacco culture.

The surface soils are generally brown to dark brown, 8 to 10 inches deep, underlaid with light brown or yellow brown subsurface layers, usually have a reddish, clayey layer fairly well developed just above the substratum where this consists of interbedded sands and gravels. This is usually very evident in sections exposed in gravel pits in many parts of the country. In some cases the substratum may be clay and the red layer will be absent, but the lower layers of the sandy soil will be mottled.

Sandy soils, which are flat or low lying, will be found to have either mottled or grey wet sand substratum often called "quicksand" and are subject to frosting, so should be avoided as a general rule.

Generally speaking, heavy soils such as clay loams and clays are not well suited to the production of a light colored leaf of good quality. In wet seasons the deficient drainage may result in drowning out of plants and in very dry seasons, as the reserve moisture in the compact subsoil may not be sufficient to carry the plant over the critical period, the plants are stunted and poor quality tobacco is the result.

DARK OR BLACK TOBACCO SOILS

The dark or black tobacco is being produced on a variety of soils, ranging from sandy loam to heavy clay and even black organic loams and mucks, provided these latter are adequately drained.

Frequently it does well on soils which are rather dark in color and too high in organic matter and nitrogen to produce a bright, fine quality plant of the Burley type.

On the whole, well drained fertile soils ranging from sandy loams to light clay loams in texture, may be used with very good results for the growing of dark tobacco. While there are some exceptions to such wide soil recommendations, it is possible by observation and study of the growth of the tobacco on these various soils, provided climatic conditions are satisfactory, to modify fertilizer and cultural practice sufficiently to produce a high quality dark tobacco on almost any one of them.

TOPOGRAPHY AND AIR DRAINAGE

Attention should be paid to the question of protection from prevailing winds in the case of the sandy soils. Their organic matter content is naturally low and the particles of surface soil have barely enough organic matter to bind them together and prevent the soil from blowing or drifting. The presence of stump fences in the old pine timbered districts and the shelter afforded by existing bushlands should be taken advantage of as much as possible where soil conditions are suitable. The "lay" of the land or its topography is also important in determining the air drainage. Depressions or swales are apt to be cold air pockets and increase the liability to frost injury. Fairly smooth, gently sloping topography tends to obviate this danger and where the slope is to the southward is a further advantage due to the earlier warming up of the soil in the spring.*

ROTATIONS FOR TOBACCO

One of the most difficult questions to answer with regard to tobacco growing is that dealing with the rotations in which tobacco should appear. It is for every man a different problem and can be solved only by him after a study of his own particular situation.

With the changing crop conditions in Southern Ontario, due to the ravages of the corn borer, farm management is going through a period of re-construction, and old successful rotations must be modified.

Tobacco should not appear too often in the rotation and, to be worked out satisfactorily over a series of years, a four year rotation should be the minimum. Such a rotation as the following might be suggested:—Corn or Barley, tobacco, wheat and hay. Longer rotations than those of four years are probably to be recommended, if the operator has the available land, although experimental work done at the Harrow Station would indicate that the longer rotations are not desirable for Flue-cured tobacco.

TOBACCO SEED BEDS

The Importance of Good Plants:

Under Ontario conditions, even in the most favored districts for tobacco growing, the crop requires every advantage possible to ensure its maturity before frost threatens.

To have the crop well started, so that it may make full use of June and July growing weather, is favorable to a large yield of early maturing tobacco. The aim of all tobacco growers should be to produce good sized plants that have plenty of roots, that have not been too crowded in the plant beds and that have been properly hardened before transplanting. Such plants become established quickly in the field and are likely to require very little re-setting. The resultant crop grows uniformly and facilitates the harvesting operations.

Types of Seed Beds:

1. Open Beds

In the early history of tobacco growing in Ontario, open beds were used for growing the plants. A sheltered but open space in a woodlot was selected and a pile of brush was burned over the site of the bed. The soil was stirred and put into fine tilth ready for sowing. Good plants are reported to have been grown in this manner. However, with changing conditions and the need of greater control over the growing plants and the pests to which they are subject, open beds have been replaced by more protected types. In parts of the southern United States, the open type of bed is reported to be still in use.

2. Frame Beds:

The most used type of bed to-day is the frame bed with some form of covering. Frame beds comprise the following classes: (a) Cold beds; (b) Semi-hot beds; (c) Hot-beds.

Covering materials, which may be used, are: (a) Light cotton; (b) Glass substitutes as glass cloth, cello-glass, etc.; (c) Glass sash.

The Location and Site of a Frame Bed: It is important to choose a sheltered location such as is found on the south side of a barn or a high board fence where adequate protection from cold winds may be secured and yet the maximum amount of sunlight obtained.

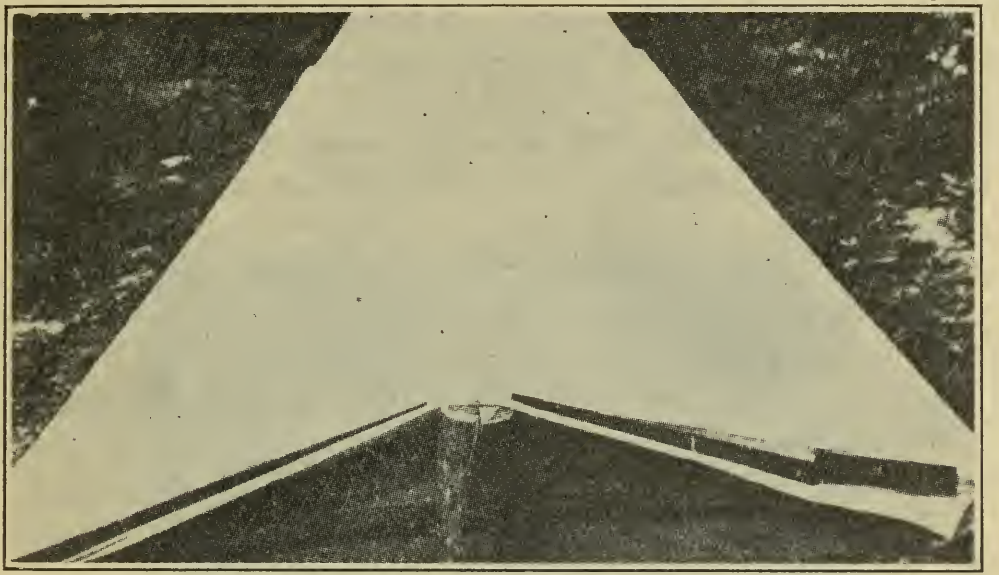

Fig. 4.—A properly covered canvas bed.
Note the raised centre. Cotton covered beds are not dependable for early plants. (Courtesy, Tobacco Division, Dominion Department of Agriculture, Ottawa.)

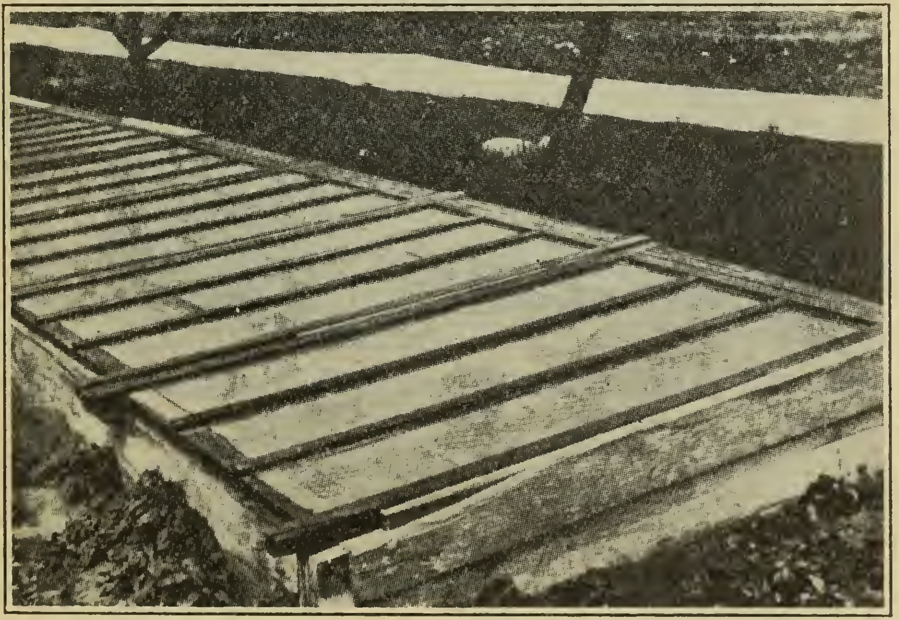

Fig. 5.—A good type of bed for early plants.
The semi-hotbed under glass produces good plants for early transplanting. (Courtesy, Tobacco Division, Dominion Department of Agriculture, Ottawa.)

The ground should be well drained and is the more desirable if of a sandy or gravelly nature. The surroundings should be such that they may be kept clean of refuse and free from weeds in order to control, as much as possible, the danger from insect pests and plant diseases.

Plenty of room should be left between beds to enable carrying out the operations of removing and renewing the soil within, watering, caring for the beds and for sterilizing the soil.

General Construction of Frame Beds:—

One inch pine lumber is satisfactory material to use.

The front or south side should not be less than six inches above the level of the ground and may well be eight inches. The back or north side should be higher so as to allow a slope of one inch for every foot in the width of the bed.

A popular width of bed is five and one-half feet inside measurement. This allows for the use of standard hot-bed sash which are six feet long.

A stiffener of two by four scantling should be run along the outside of the bed to come flush with the top of the boards. This is particularly desirable where sash are used and tends to keep the boards from bowing in and leaving open spaces underneath the edges of the sash.

In length, the beds may be made to any convenient distance desired. Cross braces are used at frequent intervals and should be of strong material but narrow in width.

COVERING FOR BEDS:

Cotton—Where cotton is used, it should be light and not likely to produce shading or prevent good air circulation. It is stretched tightly across the bed and tacked to the sides in such a manner that it may be rolled back to enable watering and proper care of the plants.

Sash: Standard hotbed sash can be purchased more cheaply from the greenhouse construction companies than can special sash be manufactured. The standard sash are 6 ft. x 3 ft. and are composed of single lights of glass set in light-weight cypress frames.

Glass Substitutes: There are other materials which may be used but in general they have not proved so satisfactory as glass. Until some material as efficient and durable, obtained at less cost, can be secured as a glass substitute, the ordinary glazed sash are to be recommended. Where sash are used, the beds will require close attention during warm weather to prevent burning of the plants.

COLD BEDS:

This type of bed is made with the use of a frame and some covering material. It is prepared by having a layer of good earth four or five inches in depth on the bottom of the bed, covered to a depth of an inch or two with black muck soil, forest mould or well rotted compost. This top layer should be fine and free from coarse material but its general texture should contain plenty of fibre so that it will not become hard or baked.

No extra heat is provided in this type of bed and the soil in which the plants grow is next the cold ground. In cool or cloudy weather, it is impossible for a good growing temperature to be maintained. This is the least desirable type of frame bed.

SEMI-HOT BEDS:—

This type of bed makes similar use of the frame and covering as does the Cold Bed, but differs in that an insulating layer lies between the cold ground and the soil in which the plants are grown. The insulating layer is capable of affording improved drainage and, in some cases, of giving off a certain amount of heat. It may be made up of corn stalks, straw or similar material. Some growers use a light layer of horse manure or a mixture of horse and cow manure not more than three to four inches deep on top of the rough material. The fermenting manure, if too great a quantity is used, is likely to create too much heat and force growth too rapidly, giving weak, spindling plants. In general, the manure is not advised, as the very best of early plants may be grown without its use or its dangers.

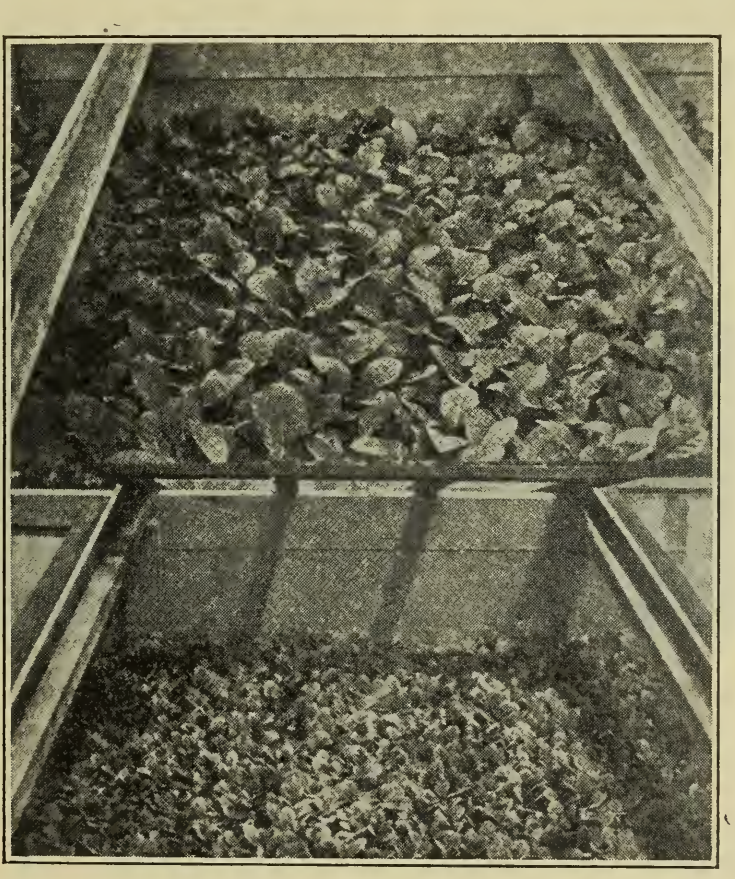

Fig. 6.—A comparison of glass-covered semi-hotbeds and cold bed.
(Above) Glass covered semi-hotbed.
(Below) Glass covered cold bed.
In both beds, the variety was the same, the date of seeding was the same and the photographs were taken the same day. (Courtesy Tobacco Division, Dominion Department of Agriculture Ottawa.)

Preparation of Semi-hotbed: The soil within the frame area, to a depth of about eight inches, is removed. A layer of corn stalks, straw or similar coarse material is placed within and well tramped to a depth of six inches. On top of the corn stalks, a five inch layer of the soil which had been previously removed is worked in so that it will remain solid and not settle, thus causing depressions in the bed. The final layer is put on to a depth of about one and one-half inches and may be of black muck, forest mould or good compost. It should be raked smooth and level, preparatory to seeding and firmed with a light packer. Soil may be banked up around the outside of the bed for added protection.

This type of bed has proved the most efficient of any frame bed in the experimental work of the Harrow station. It is highly recommended for use with both cotton and sash covering. With a sash covering it gives best results, where the operator uses care in regulating the temperature and moisture requirements.

HOTBEDS:

With such an efficient type of bed as the semi-hotbed, there should be very little use for hotbeds in growing tobacco plants. They are designed more for forcing plants and good tobacco plants should not be forced. In construction, hotbeds are very similar to the semi-hotbed except that, in place of the corn stalks, fermenting manure is used to a depth of eight to twelve inches. Only under special circumstances would we recommend the use of a hotbed.

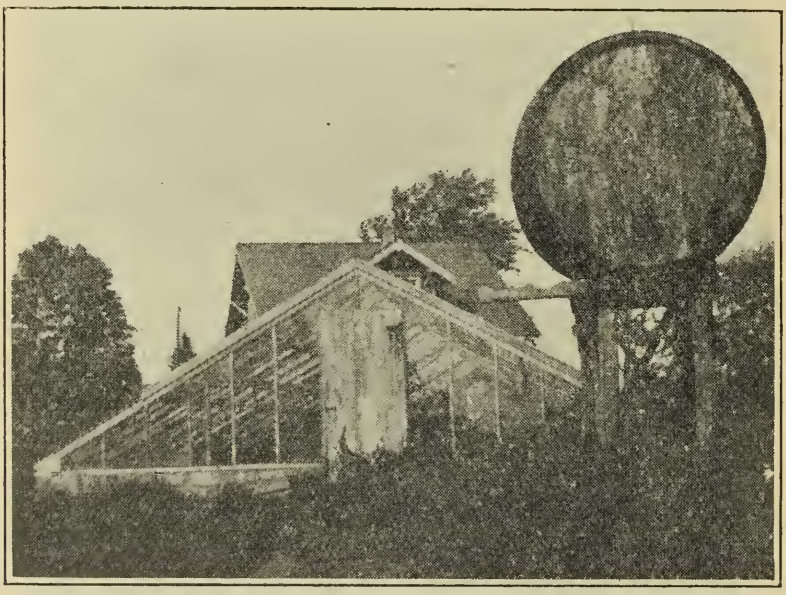

Fig. 7—Single small greenhouse for plant growing.

GREENHOUSES

Particularly in the districts where flue-cured tobacco is grown many of the larger operators have built small greenhouses in which to grow their tobacco plants. In most cases, these houses are used for this purpose only.

In construction they are somewhat less expensive than the all year round general greenhouse. Most of them have very little wall, the roof running down to the ground. Many are home constructed, and heating plants vary from a stove to a steam boiler.

Watering in some is carried on by means of overhead sprinkling. In all cases, the plants are grown on the solid earth in beds prepared as in a cold bed.

Conditions under which the plants grow can better be regulated in a greenhouse than elsewhere and so this method offers, perhaps, the best way of growing good plants, provided a grower considers the expense justified.

SOIL STERILIZATION:

Thorough sterilization of the soil in the seed bed is considered to be essential before sowing Tobacco seed. There are numerous seed bed organisms which may attack the young plants while they are growing, some of which may be carried to the field and there develop and prevent the proper growth of the plants.

"Damping-off" is one of the most common troubles which beset the tobacco plant grower and, through this disease, he is likely to lose a large part or perhaps the entire bed. Sterilization also controls weed growth and will effectively kill weed seeds which may be present in the soil.

The most effective and the most successful method of soil sterilization is through the use of steam and is applied by means of a broad, flat, shallow pan, which covers the surface of the bed, and which will allow the steam to diffuse over the surface of the bed and penetrate into the soil. Steam, under pressure of 100 lbs. applied for at least thirty minutes, is found to give good results, when the pan is properly banked so that it does not allow the escape of steam. The pans are made about nine feet in length. Steaming may be carried out either in the Spring or the Fall. If the beds are sterilized the Fall previous to use, they should be well covered over to prevent re-infection of the soil.

There are various chemical treatments recommended for the sterilization of seed beds. Formaldehyde treatment is effective against disease but none of the other treatments leave the bed in such good condition for plant growth as does the steaming.

SEED SOWING

Seed Sowing must be carefully done. The tobacco seed is very tiny and a small quantity contains a great many seeds. Sowing too thickly is almost certain to bring about a growth of plants that will not be satisfactory, because of their crowded condition, and their tendency to grow long and spindling with a consequently poor root system.

In preparation for sowing seed, the bed surface should be lightly tamped so that the surface is level and smooth. A piece of plank with a handle attached is suitable for this purpose.

The safest way to sow the seed is by mixing with some good carrier made up of very fine particles, such as sifted wood ashes or very fine sand or dry and heated fibrous soil, which has been finely sifted.

The rate of seed sowing recommended for Burley tobacco and similar types is one-seventh ounce to one hundred square feet of bed area. Roughly, this amount of seed is about equal to what may be contained in a moderately heaping teaspoonful. The amount of material to be mixed with the seed will depend on what method the grower wishes to use in sowing the seed but, at any rate, it should not be too great and only enough to insure having even distribution of the seed over the recommended area. The seed mixture may be sifted onto the bed, using a fine screen. The difference in color between the seed mixture and the soil of the bed will show the progress of the operation.

After sowing, the surface of the bed should be lightly tamped once more before being sprinkled.

WATERING:

Following the seeding of the beds, the surface is sprinkled lightly with water, using a fine spray nozzle so that it will not cause the seed to wash together and become bunched.

From now on the beds are kept only sufficiently moist so that they do not dry out. It is preferable to do the watering in the mornings of bright days, even after the plants are well developed. Frequent watering during warm weather is often necessary, particularly when the plants are being grown under glass.

VENTILATION:

The young plants require a certain amount of ventilation from the time of their earliest growth until they are removed from the beds. Ventilation should increase as the plants develop and particularly is this necessary where sash are used. Ventilation must be watched very closely in warm weather, when the sun is bright.

"HARDENING-OFF":

Before the plants are transplanted to the field, they should undergo a hardening process. This should not be carried too far so that the plants develop woody stems.

Starting about one week before the plants are to be pulled, the water supply is gradually cut down and ventilation is increased. During the last three or four days, the coverings of the beds should be left off both day and night.

HASTENING-GROWTH:

Under the best conditions, the plants should develop normally without any need of a stimulant. Frequently, however, due to backward weather conditions or some other cause, the plants may be making slow growth and, if this is the case, an application of nitrate of soda in solution at the rate of about 2 lbs. of nitrate of soda to forty gallons of water might be given. This application should not be made in any case before the plants in the bed have developed leaves, which would cover an area equal to that of a fifty cent piece

If considered necessary, a later application may be made in about two weeks time. Do not use this stimulant unless necessary and, after applying it, follow immediately with a sprinkling of pure cold water to wash off the leaves.

FIELD CULTURE

PREPARATION OF THE SOIL

The early preparation of the soil in which the tobacco crop is to be grown has a very important bearing upon the yield and quality of the ultimate crop. Many a poor crop can be traced back to neglect on the part of the grower in meeting this requirement.

Where possible, fall plowing should be practiced with all soil types. Plowing at such time not only assists to improve the physical quality of heavier lands but also helps to eradicate weeds and to control insect pests. It is also desirable to fall plow for tobacco where a green crop or manure is turned under.

Spring cultivation should be commenced as soon as possible, using implements which will bring the soil into the best possible state of tilth and which will tend to conserve moisture. Should spring plowing be necessary, the earlier it is done the better and subsequent cultivation should be maintained in all cases so as to rid the ground of weeds before the crop is planted. A fine mulch should always be maintained on the surface of the soil. The tobacco crop requires all the moisture that may be retained in the soil.

FERTILIZERS FOR TOBACCO

It is not practicable to attempt to grow any tobacco crop without either the use of barnyard manure or commercial fertilizers and often a combination of the two gives excellent results. The quality of tobacco is generally improved through the use of commercial fertilizers to provide, at least, a portion of the plant food.

Ten loads of manure per acre should prove sufficient for the Burley and Dark types of tobacco. For Flue, less manure is generally advisable, except where very poor land is used. It is thought by many growers that the best time to apply the manure is in the Fall, before plowing. If very well rotted manure could be secured, it should be suitable for Spring cultivation but, in order to avoid growing coarse, rank tobacco, fresh manure is best applied either to a previous crop or as a fall application.

The use of commercial fertilizers is generally accepted by tobacco growers who strive to produce maximum yields of high quality tobacco. Only high grade fertilizers should be used, that is, fertilizers with a relatively high analysis and made up of readily available materials. In general, for Burley tobacco, 4-8-6 applied at the rate of from 500 to 1000 lbs. per acre is to be recommended and a 4-8-4 at the same rate of application is recommended for the Dark types of tobacco, which are usually grown on somewhat heavier soils. It must be understood, however, that conditions vary and each grower should determine for himself what fertilizers give him best results commensurate with the cost of fertilizer.

The tobacco grower may be guided somewhat by the following information:

An excess of nitrogen tends to produce a dark, coarse, late maturing leaf, whereas the deficiency of nitrogen will make for a small thin leaf and a light total yield. Also, nitrogen applied in a slowly available form would tend to delay maturity and to give a coarser leaf. A well-balanced fertilizer made up of readily available materials should be such that it provides all of the plant food required by the tobacco crop while growing and in only such quantity that it is used up by the end of the growing season. If this condition is met and the crop grows normally, it should mature quickly and give the maximum in both quality and yield.

There are two methods of applying fertilizers in general use. Some growers still broadcast their fertilizer over the field. However, where a proportionately small application is being made, it is likely that the plant receives more benefit from the fertilizer when it is drilled along the row. This latter method can be accomplished through the use of a potato planter with fertilizer attachment or by using a regular fertilizer drill, which operates along the same principle. With this method of drilling-in the fertilizer, a further advantage is also secured in that a slight ridge of loose soil is left for the tobacco transplanter to follow and the plants, when set along this ridge, seem to be benefited through being raised slightly above the general field level.

Some few growers prefer to use the grain fertilizer drill running three tubes for each row of tobacco and removing the intermediate tubes. This, probably, is the next best method to that of applying the fertilizer with a good fertilizer drill, where a large acreage is to be grown.

The objection is sometimes made that in the succeeding crop after tobacco, which is usually a grain crop, part of the crop, which grows directly over the rows where the tobacco was, receives benefit from the application of the fertilizer, which was applied to the tobacco crop and that in between the rows does not make such good growth. This, however, is only a minor objection when one considers the amount of fertilizer saved and the results obtained on the tobacco crop by drilling as against broadcasting.

Transplanting Tobacco

The sooner the tobacco crop may be started on its growth in the Spring, the better are the chances of maturing a good crop before the danger of Fall frosts arrives. Transplanting should commence as soon as possible after the Spring frost danger is past.

In order to be sure of early planting, the grower must have a good supply of well developed plants on hand. Immediately previous to pulling the plants, thoroughly water the beds. The plants are pulled from the beds by grasping the tips of the largest leaves between the fingers so that no damage is done to the heart of the plant in the operation. In order to save all possible small fine rootlets, the soil in which the plants are growing should have been prepared from soil of a fine open texture. The greatest care is necessary in handling the plants from the bed to the field and they should never be allowed to become dried out through undue exposure to wind and sun. Spindly, unhealthy or diseased plants should always be discarded, as should plants which have not a good root system. For a good crop, use only strong, robust, well-rooted plants. When transplanting during very bright warm weather, wait until afternoon so that the plants may not become too wilted and burned.

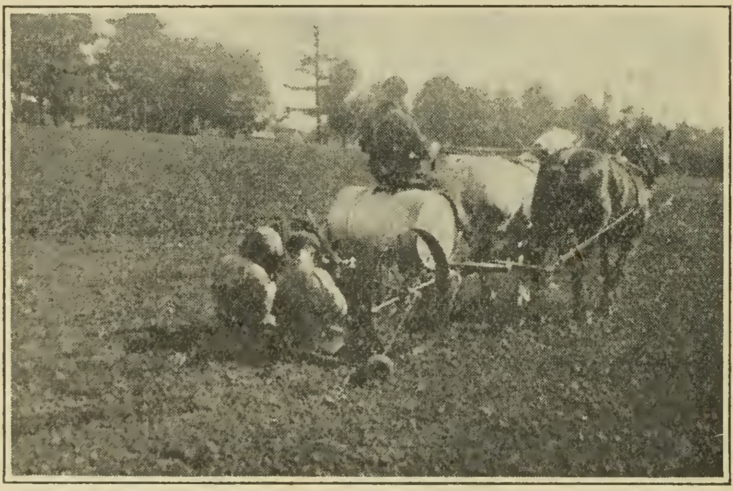

Fig. 8.—Transplanting Tobacco.

Transplanting on large acreages is usually done by means of a horse drawn transplanting machine. Growers of small areas of tobacco frequently transplant by hand but this is not practical where extensive operations are carried on. The transplanting machine is drawn by two horses. Two men or boys handle the plants. The machine opens a drill and, at the specified intervals, allows a spurt of water from that carried in the tank of the machine to go into the drill. At this point the roots of the plants are set and the attachment which follows draws the soil close up around the stem of the plant.

In general, all the transplanting machines work on the same principle and may be regulated as to the distances between plants, the amount of water applied and the degree of packing of the soil around the plant.

The distances at which the plants are set depends on the condition of the soil and on the variety of tobacco being grown. A very fertile soil can naturally stand heavier growth than a poor soil not sufficiently fertilized. As a general rule, the following distances for the specified types of tobacco may be recommended:—

Burley, 42″ rows, with plants 28″ to 32″ apart.

Black Tobacco (Green River), 44″ rows with plants 28″ to 32″ apart.

Flue-cured Tobacco, rows 36″, with plants 24″ apart.

Close planting makes for a thinner leaf and a lighter yield while planting too far apart is likely to produce a leaf that is heavy and coarse.

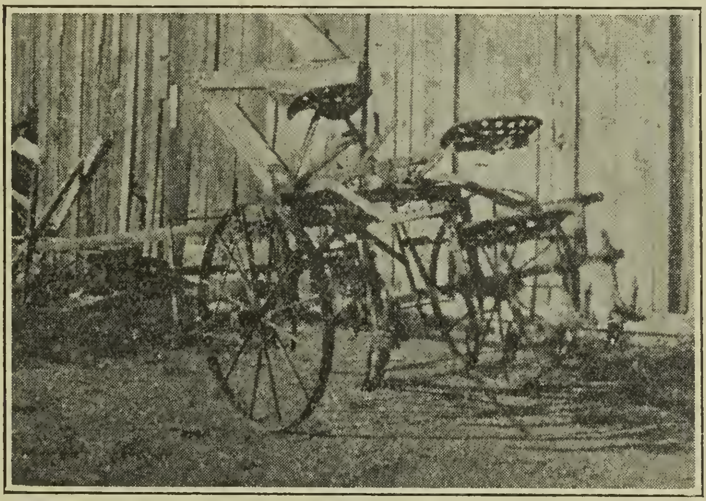

Fig. 9.—A two-horse cultivator with which hand-hoe attachments are used.

It will be four or five days after the plants have been set out before they will have straightened and commenced to take root in their new surroundings. Following this, the grower should, during the next few days, reset all plants that have died or which have been damaged by insect pests. Frequently, it is necessary to do this resetting two or three times in order to secure a good stand. A good stand is necessary to ensure highest yields.

The actual resetting is usually done by hand, the grower carrying a basket of plants, whose roots have been puddled or otherwise kept moist and using a dibble with which to make a hole for the plant.

Occasionally, during a very dry, hot spell, it may be necessary to carry water to use in the hole with the plants, when resetting.

CULTIVATION

The inexperienced grower should be careful not to start cultivation operations too soon after the field is planted. The first cultivation should not commence until about eight days after planting and then should consist of loosening the soil about the plants with a hand hoe. Two or three hoeings are usually necessary and a good rule to follow with the cultivation is to maintain a surface mulch. Weeds have no place in a tobacco crop and in a normal season all practices should tend toward moisture conservation.

While the tobacco is small, a two horse cultivator, which cultivates on both sides of the row, is usually used. There are modifications of this type of cultivator and one of the most popular of these is that with a hand hoe attachment, which is operated by a second man who rides on the cultivator. Later, a one horse spike tooth cultivator may be used for as long as the tobacco needs cultivating, which is usually up to the time when topping starts. The first cultivation should be deep, subsequent cultivations gradually becoming more shallow as the plants get larger and the roots expand, so that finally, only the very surface of the soil is stirred. To continue cultivation after topping has been done is likely to retard maturity.

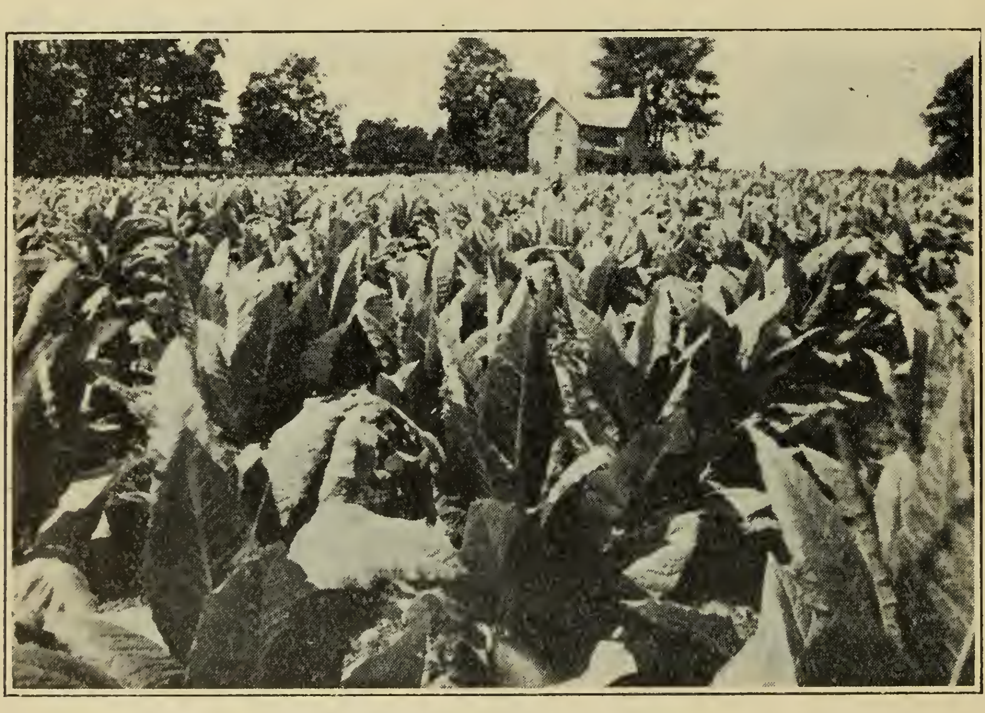

Fig. 10—Stand-up Burley tobacco.

TOPPING

"*Topping*" is usually commenced at about sixty days from the date of transplanting the tobacco to the field and consists in breaking off the growing top or bud of the plant, preventing further growth upwards and allowing the strength of the plant to go into the development of the leaves, which have already formed. Good judgement must be exercised by the grower in this operation because plants topped too high are slow to mature, growing small, narrow leaves, which will not develop at the same uniform rate. Low topping may cause to develop thick, coarse leaves. About fourteen good leaves are sufficient.

Small plants and re-sets will not be ready to top when the larger plants are fit and the grower will likely find it necessary to go over the field two or three times before all the plants are finished. With these later plants, topping should be done so that they will mature as quickly as possible and be ready when the main crop is fit to harvest. In order that this may take place, the later plants are usually topped lower than the earlier ones. Eight to ten leaves on a late plant are sufficient.

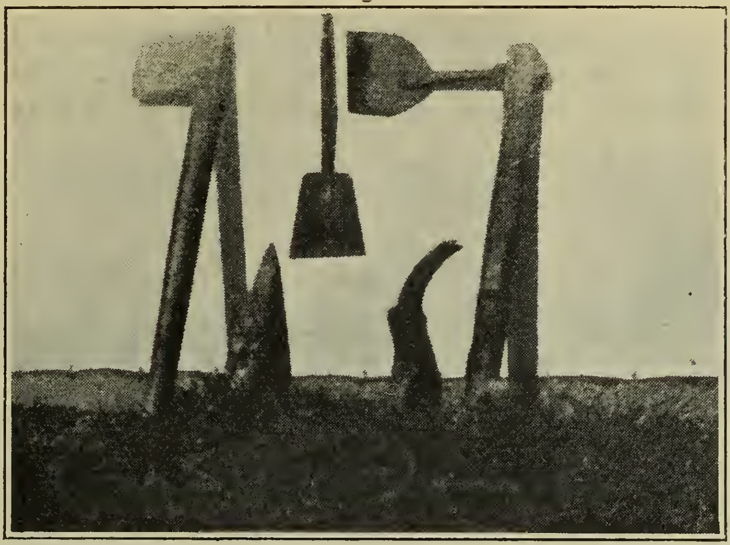

Fig. 11—Tobacco harvesting tools.

Tools (from left to right): 1. Combination splitting and cutting tool. 2. Needle for placing on end of pickets. 3. Splitting tool. 4. Splitting knife. 5. Hatchet or cutting tool.

SUCKERING

Following the "topping" operation, suckers will start to grow in the axils of the leaves and these must be removed as often as is necessary. They usually are allowed to become four or five inches in length before removal and it may be necessary to sucker the plants as often as three times before harvesting commences.

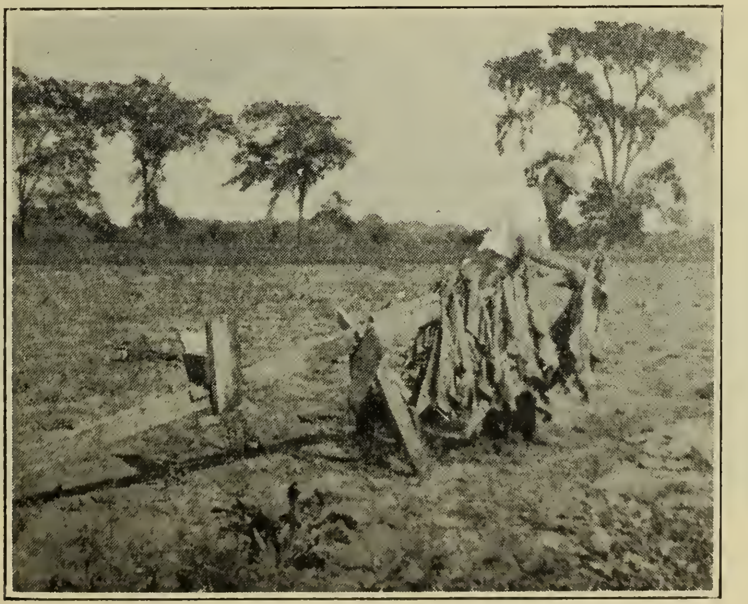

Fig. 12.—Needling tobacco using a wooden horse to hold the pickets.

Suckers should not be allowed to grow too large as they are extremely detrimental to both the yield and the quality of tobacco. The last suckering may be done just previous to cutting.

HARVESTING

From thirty to forty days after topping, the plants should be ready to harvest.

Maturity is indicated when the leaves of the plant develop a somewhat lighter colour and take on a uniformly mottled appearance, which is brought about by the change of the green colouring material in the leaf to an indefinite yellow spotting. Another test which might be made at this time is to fold back a portion of a top leaf between the thumb and the fore-finger. Where it is pinched, a clean crack is made when the plant is mature and ready to cut.

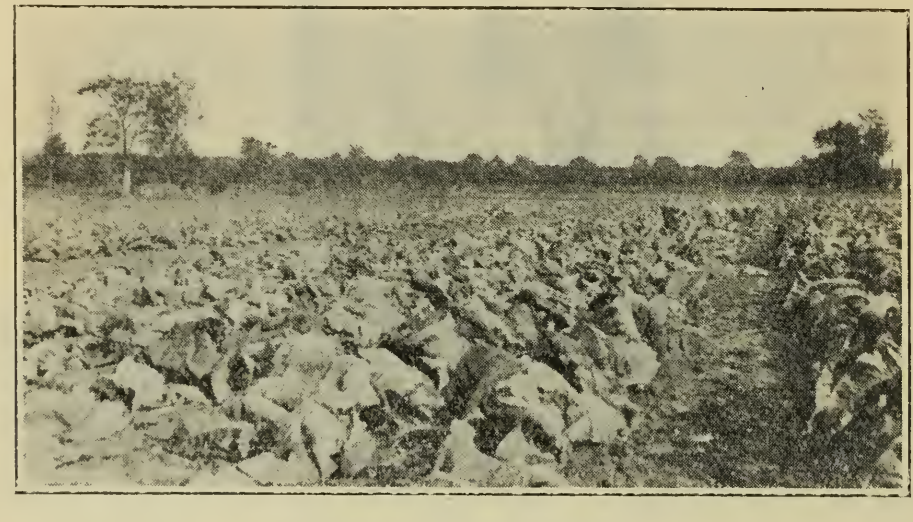

Fig. 13—Cutting tobacco.

Two common methods are used in harvesting—the one is to cut the plant close to the ground and below the bottom leaves with a small hatchet, allowing the plant to topple over in the row where it stood. The plant is allowed to lie where it fell until well wilted. The time necessary will depend largely upon the condition of the weather. When wilted, it may be piled, putting not more than about fifteen plants in a pile and usually piling three rows in one to facilitate the later operations. Following this, the plants are speared onto a tobacco picket by means of a sharp-pointed, needle-like attachment, which is slipped

Fig. 14—Needling and loading tobacco.

over the end of the picket. Five to seven plants are placed on each picket and spaced evenly. In this operation, a wooden horse or tressle-like affair is often used in order to hold the picket while the plants are being speared on and also to carry a quantity of pickets.

The other is the Split-Stalk Method, and differs from the former in that before the stalk is cut, it is split with a special knife down the centre from the top to within about six inches of the ground. The plant is then cut off and allowed to wilt as before. After wilting, the plant is hung over the picket, placing the same number of plants on each and spacing them as with the needle method.

The Split-Stalk Method is particularly recommended for large tobacco plants, as it will enable the plants to cure out more thoroughly and more quickly than where the needle is used.

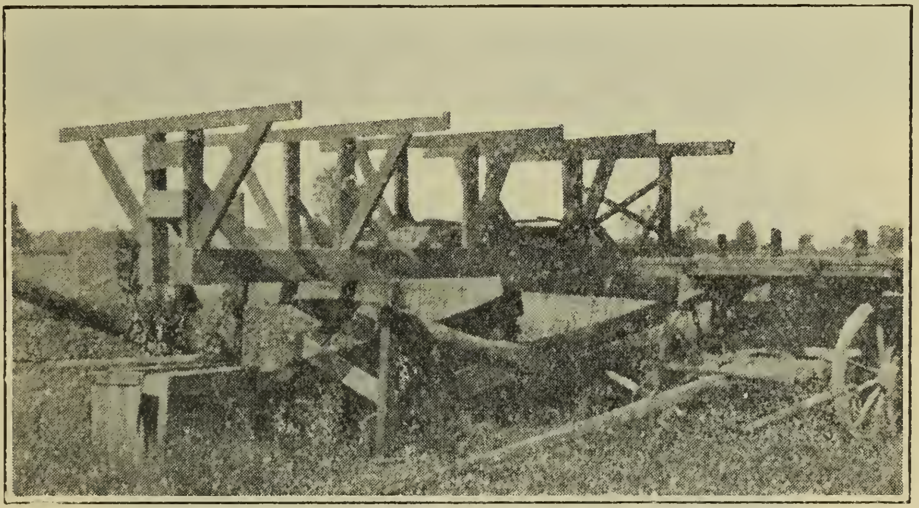

Fig. 15—A one man loading rack.

With Flue-cured tobacco, the crop is cut and taken directly to the curing barns, not being allowed to wilt as in the case of the Burley and Black tobaccos. Do not cut tobacco when it is wet if at all possible to avoid, for much more damage to the leaves is likely to result.

Hauling

Tobacco is hauled from the fields to the barns by means of wagons or trucks. The most common method is to pile the tobacco on flat racks, usually making two piles. The pickets are laid flat with the butts outward and the leaves over-lapping. Care must be taken to not bruise or unduly damage the leaves since such marks impair their appearance and quality.

Some few growers use a specially constructed rack upon which the pickets may be hung. This method, though less pickets may be hauled in a load, has certain advantages. The rack in the illustration shows the following advantages:—

1. The pickets may be loaded by one man.
2. The tobacco is not so likely to suffer damage.
3. When unloading, one man's labor in the barn is saved because of the high rack.

CURING

AIR-CURING:

The first few weeks, all possible ventilation should be given until the tobacco is fairly well cured and then the ventilation may be decreased somewhat, if the weather has been contiuously dry, so as not to hasten the curing too fast. During short periods of damp, muggy weather, it is advisable to close the ventilators so as to keep the inside of the barn as dry as possible. In continuous wet weather, it would probably be well to open the barn and to allow for the maximum of ventilation. After the tobacco has become fairly well cured and is more or less dry and brittle, it is well to close the side of the barn toward which the wind is blowing, in order to prevent damage to the leaves through being whipped about.

Usually, even under favorable curing conditions, air-cured tobacco will not be ready to take down before about the middle of December and, frequently, it is necessary to allow it to hang considerably longer.

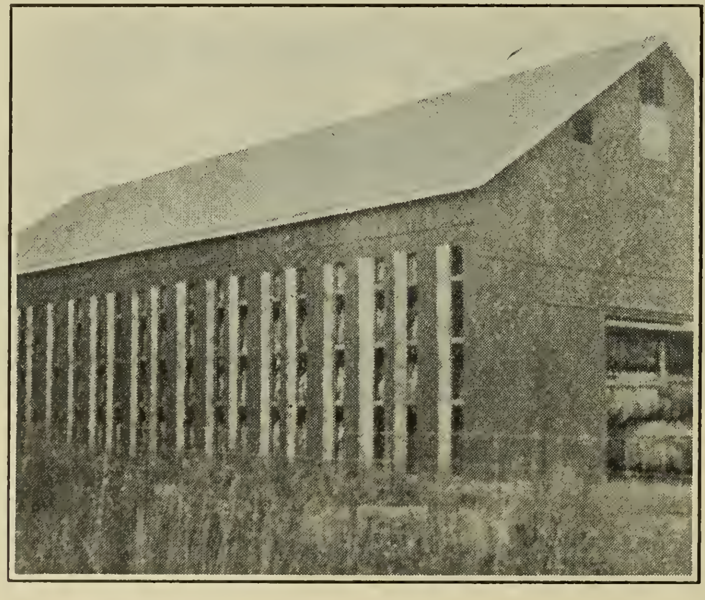

Fig. 16—A popular type of barn for air-curing tobacco.

CURING BRIGHT LEAF TOBACCO:

Flue-cured or Bright Leaf Tobacco requires the most careful attention in the curing process of any of the types grown in Ontario. Many of the large growers, who have been producing this type of tobacco for some years, depend entirely upon experts for the curing of the crop, who are brought for this purpose to Ontario from the southern States each season.

However, important as the curing is, a first-quality product cannot be secured, even though curing operations are carried out perfectly, unless the crop has been grown and handled properly. To obtain most satisfactory results in the curing of bright leaf tobacco, it is necessary that each kiln should be filled with tobacco of uniform colour and maturity.

The kiln should be so constructed that it is as tight as possible and yet has proper facilities for providing ventilation, when necessary in the curing process. Ventilation is arranged so that fresh air is admitted at the bottom and the heated moisture-laden air, which passes up from amongst the plants, can escape through the ventilators at the top of the gable ends of the kiln. Ventilators should be controlled by the operator from the ground.

Heat is supplied in the kilns by means of two furances, which may burn wood, natural gas or oil. The flues or pipes from these lead through the kiln along the floor in a U shaped manner back to the chimney and provide the heat necessary.

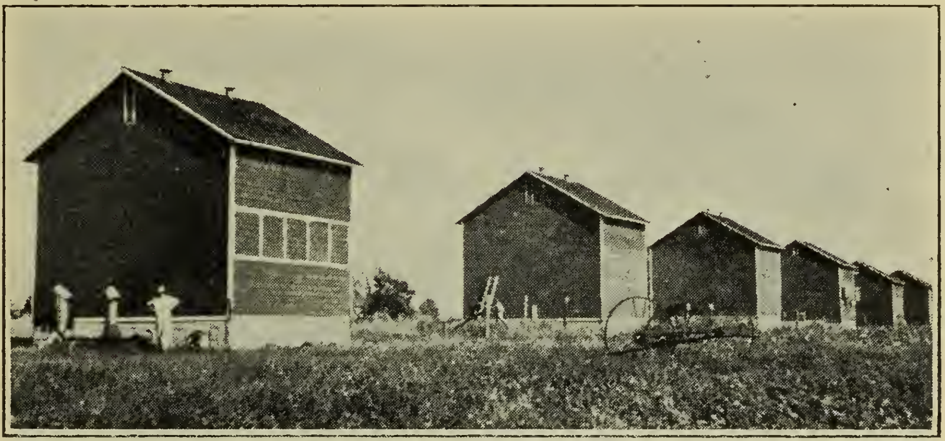

Fig. 17—A group of kilns, near Leamington.

When the tobacco is judged to be ready in the field, it is cut, hauled directly to the kiln, and the filling of the kiln is completed as quickly as possible. Should it be necessary, in order to fill the kiln, to put in both green and ripe tobacco, it is advisable to cut the green at least twenty-four hours previous to the cutting of the more mature plants.

In spacing the tobacco on the lath, it should not be crowded nor should it be hung too closely together in the kilns. Too close hanging will prevent the proper circulation of the heated air and may delay drying, thus causing an unnecessary amount of spongy tobacco.

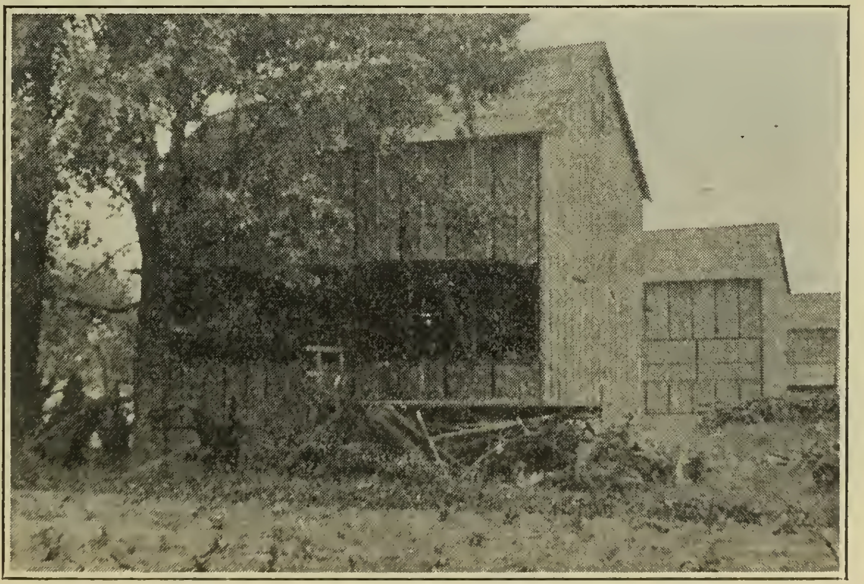

Fig. 18—A kiln in Norfolk County being filled with flue-cured tobacco.

After the kiln is filled, all the plants, leaves and trash should be cleaned up from the floor and from the top of the flue pipes, so that there will be no danger of fire developing amongst the loose leaves after they are dry.

The inexperienced grower is advised to not attempt to carry out the curing of the tobacco in the kiln without the aid of an expert. There are so many details to observe and so much depends upon experienced observation that, even with complete directions, the possibilities of partial failure are very great.

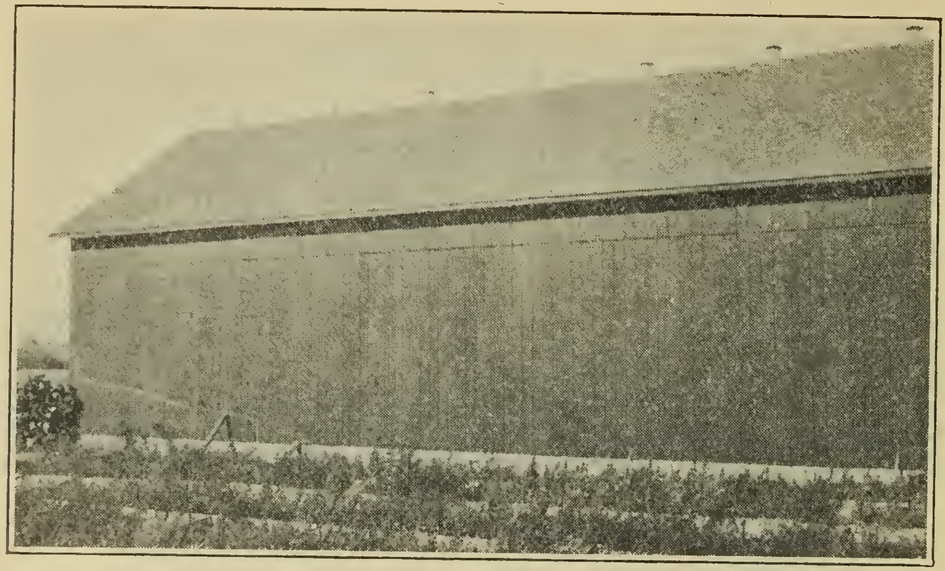

Fig. 19—A good type of barn for fire-curing dark tobacco.

CURING DARK TOBACCO WITH HEAT

Fire-cured Dark Tobacco is not produced in Ontario to the extent that any of the other types of tobacco are grown. Up to the present, fire-curing has largely been confined to the curing of a certain type of black tobacco, locally known as "snuff."

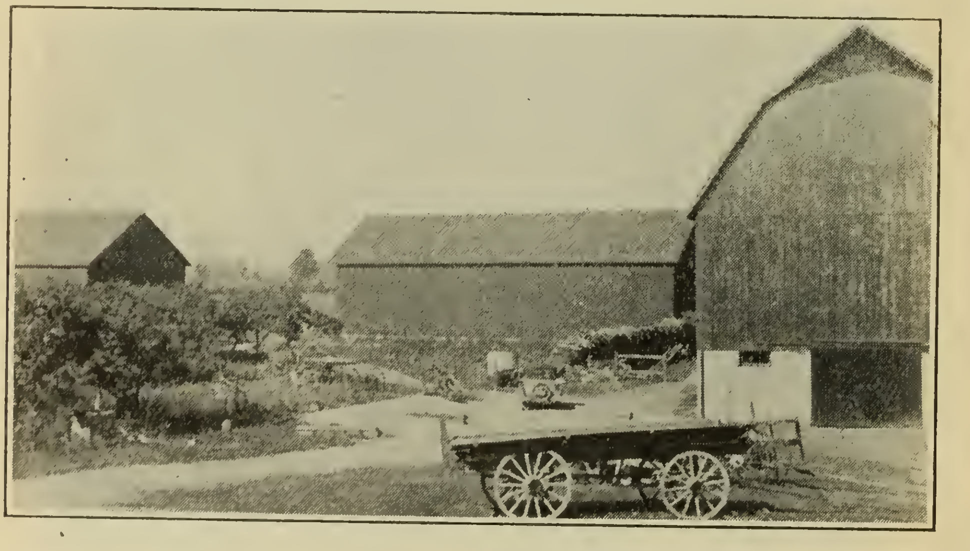

Fig. 20—A group of tobacco curing barns.
The barn in the foreground is used for air-curing, the other two for fire-curing.

The barn for the curing process is the first essential. A good type of barn recommended is one 60 to 70 ft. in length, 36 ft. wide, with posts 20 ft. in height, two to four foot concrete walls supporting the structure, and cement base posts giving support to the centre.

The above type of barn gives room for five tiers of tobacco, allowing three feet for each tier and a space of not less than eight feet between the ground and the lower leaves of the bottom tier. This space is necessary to prevent the tobacco from catching fire. Pickets are placed at from seven to ten inches apart on the tier supports.

The barn should be tight in construction so that it will hold the heat and smoke within. Small ventilators, however, should be provided in the gable ends of the barn and these should be controlled from the ground. Open fires are used in sufficient quantity along the floor.

When the tobacco is ready, it should be cut quickly, the barn filled as soon as possible, the job taking not more than a day or two. About three days after filling, slow fires are started on the floor of the barn and a temperature of 80 to 90 degrees is maintained within until the desired colour is produced, which may be described in "Snuff" tobacco as chocolate mahogany.

Corn Cobs or shavings are generally used to start the fires and, in order to prevent the fire from blazing up too much, sawdust may be used to check the flames. This will probably be only necessary during the first day or so and, by using such material, the maximum smoke with the minimum of heat is given off. Later, if more heat is desired, there is no object in holding it down.

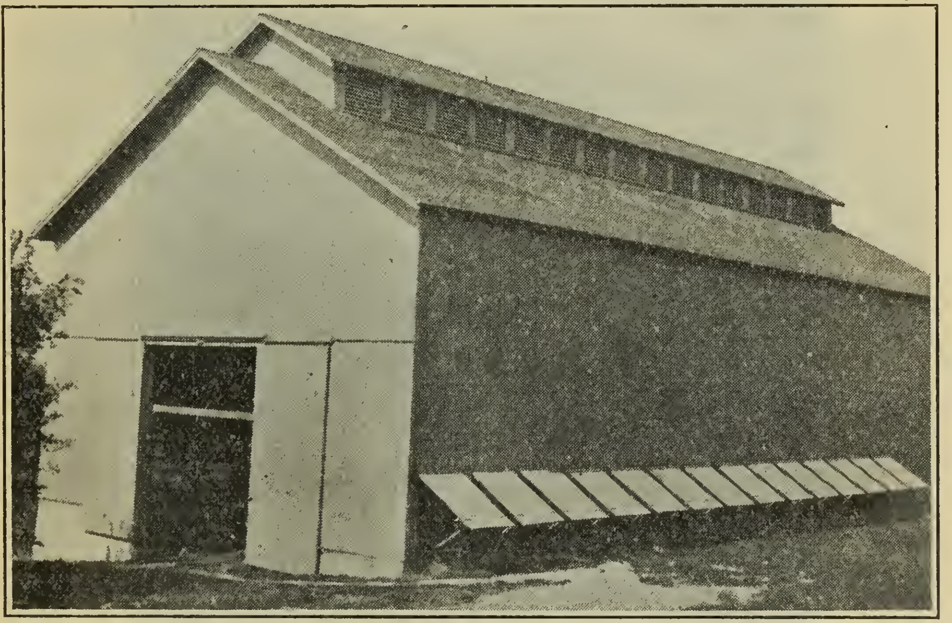

Fig. 21—A modern type of tobacco barn.
Excellent air circulation is secured by means of the ridge ventilator.

Care should be exercised to avoid applying too much heat at first. as this tends to dry out the leaf, giving a poor yield and lowering the quality. On the other hand, to heat too slowly will allow the leaf to become yellow and this is not the desired colour. The actual process of colouring the leaf usually takes a full week or better, but usually about three weeks of steady firing is required to complete the curing process. The latter part of the curing time is required to dry out the stems and stalks.

In some seasons, tobacco will sweat very readily in the barn and, if allowed to continue, will cause serious loss. The way in which to control this is to raise the temperature, open the ventilators and allow the moist air to escape and the tobacco to dry.

Once the colour has been obtained in the leaf, the heat may be gradually raised until all the leaf is thoroughly dry. When cured, the stem of the leaf will break clean. If the fire is allowed to go out before the stalk is cured, the sap from the stalk will enter the stem of the leaf and cause it to become soft, and usually a mouldy condition will result.

It is estimated by a long experienced and successful grower of "Snuff" tobacco that it requires approximately one and one-half cords of wood to fire one acre of good tobacco. Good cord wood of five to eight or nine inches in diameter is most popular. It may be of any of our native woods although elm is popular because it holds the fire well. Cord wood in the sections where this type of tobacco is grown may be purchased at a cost of $10.00 a cord delivered.

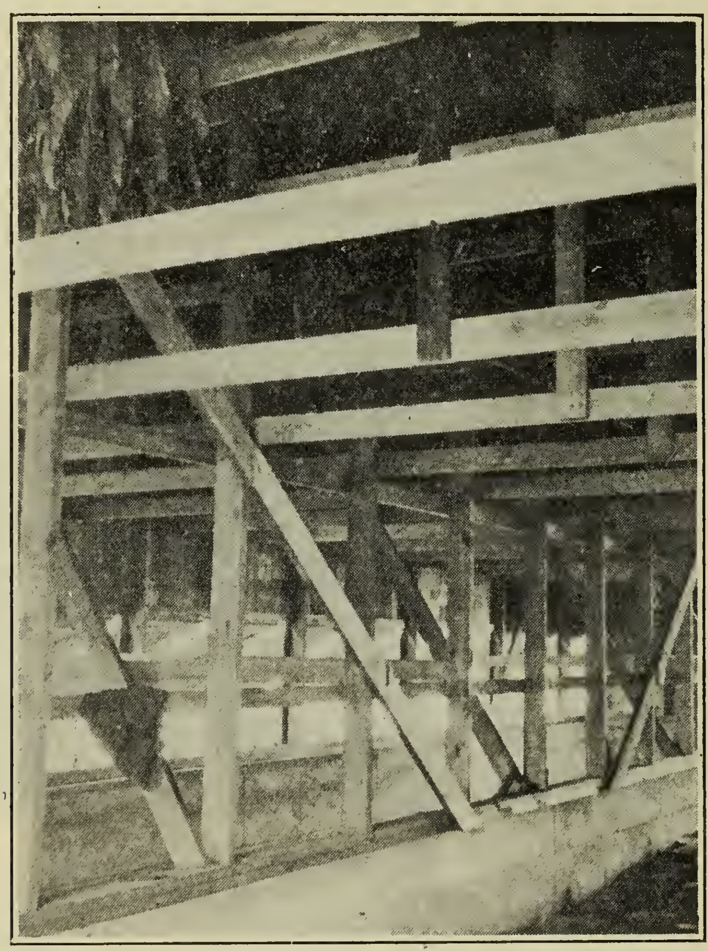

Fig. 22—Interior scaffolding of a large barn.

TOBACCO CURING BARNS

With the tobacco crop of 1925, it was estimated that approximately 25% of the crop had been lost largely through damage done after the tobacco was harvested and while hanging in the barns to cure. In explanation of this fact, it might be said that the weather prevailing during the Fall was very unfavorable for the curing of the crop. However, under any circumstances, great care must be exercised to secure proper curing of tobacco and each year more tobacco is spoiled than should be necessary.

With the development in the tobacco growing industry, great numbers of tobacco curing barns are being erected. In the past, barns of all descriptions were commonly used. A few boards were knocked loose from the sides and ends and the doors, such as they were, were left open. Further than this preparation, the matter of ventilation was left to chance. To-day, where a farmer is considering going into tobacco growing extensively, he should plan to build a special barn in which to cure the crop. A barn 36 ft. wide by 100 ft. in length with 20 ft. posts and properly scaffolded within, will hold about ten acres of tobacco. For scaffolding, 2 x 4 and 2 x 5 scantling is used for uprights and 1 x 4 material for horizontal runners of tiers. 2 x 6 material is sometimes used in the bracing.

There are two good methods of providing ventilation in the ridge of the barn. One is by building in metal ventilators at distances of about 8 ft. apart along the ridge, but the better method, though somewhat more costly, is to have a continuous venitilator running the full length of the ridge. The illustration above shows this latter type.

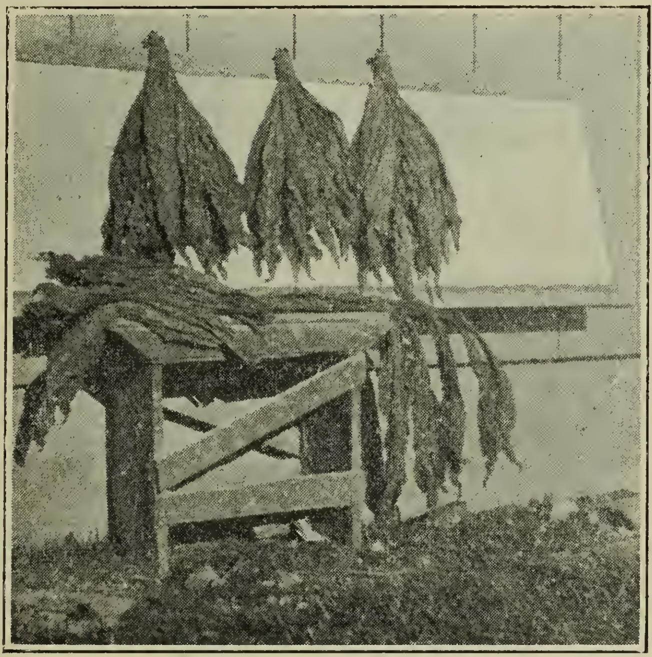

Fig. 23—Tobacco "hands."

A current of air may be made to pass from the bottom upward through the hanging tobacco by having either continuous doors running along the sides horizontally at the bottom or by having the boards, which run up and down the barn and are, opposite the standards, hinged to loosen from the eaves of the building. For air-curing, the siding on the barns is placed about one-half inch apart.

For fire-cured tobacco, the building will, of course, require to be closely constructed so as to hold the heat and smoke within.

Scaffolding should be 3 ft. 8″ wide so that when using 4 ft. pickets, there will be a 2″ lap on either end. Tiers are placed 4 ft. apart from the bottom to the top, thus allowing sufficient room for the tobacco to hang without interfering with the pickets below.

Pickets should be placed upon tiers to hang about 10″ apart or at least so that the leaves of the plant of one picket do not touch those on the next.

HANDING AND BALING

A crop, which has been harvested in good time and has had suitable curing conditions, should be ready to be stripped starting in the month of December but, unless it is fully cured, it is better left hanging. Its fitness can be ascertained by feeling the stem of the leaf near the stalk. If the stem still feels thick and fat and looks green, it is not ready for stripping.

Before the tobacco can be taken down from the curing barns, it must be in a condition in which it is said to be in "case." This condition develops during a spell of comparatively warm, damp weather. The leaves will absorb moisture from the air and will become pliable and limp, so that they may be handled without becoming broken or damaged. Tobacco pickets can then be lifted down, stripped of plants, and the plants put into piles, with the leaves lapping one another and the butts pointed outward. "Stripping" or "Handing" consists of pulling off the leaves from the main stalk and gathering them together in hands of from twelve to fifteen leaves each. The butts of the leaves are all placed together at a uniform height. An inferior leaf is selected for wrapping around the butts in order to keep the hand together.

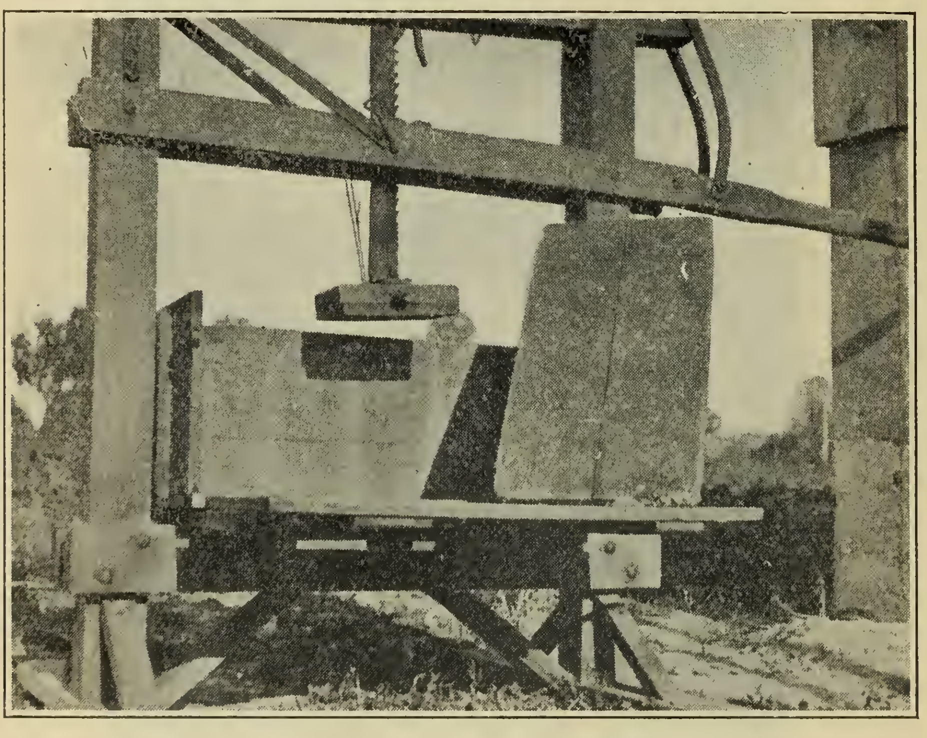

Fig. 24—Tobacco baling box.

Usually the buyers, who have contracted to purchase the tobacco crop, will designate the number of grades into which the tobacco leaves must be divided. Quite often, three grades are demanded, made up of the bottom or sand leaves, the top or tip leaves and the body leaves.

When a sufficient number of hands have been prepared, they are baled. For baling, a box is made 36″ to 42″ long, 14″ to 18″ wide and 14″ to 18″ deep.

The box should have a loose top, which may be lifted off. Notches are cut in the sides of the box to allow for the placing of the strings with which the bales are tied; five strings are generally used. Brown paper linings may or may not be required to cover the bales.

The tobacco must be laid evenly in the box, leaf over leaf, and butts towards the ends of the box. When full, the loose cover is set on top and a jack screw or lever is used to press down the hands.

The box is refilled until sufficient for a full bale of about 70 lbs. is within. Then, it is pressed again. Bales should rarely weigh more than 75 lbs.

The strings are tied, the pressure released and the compact bale removed by letting down the front side of the box, which should be hinged in order to open downward.

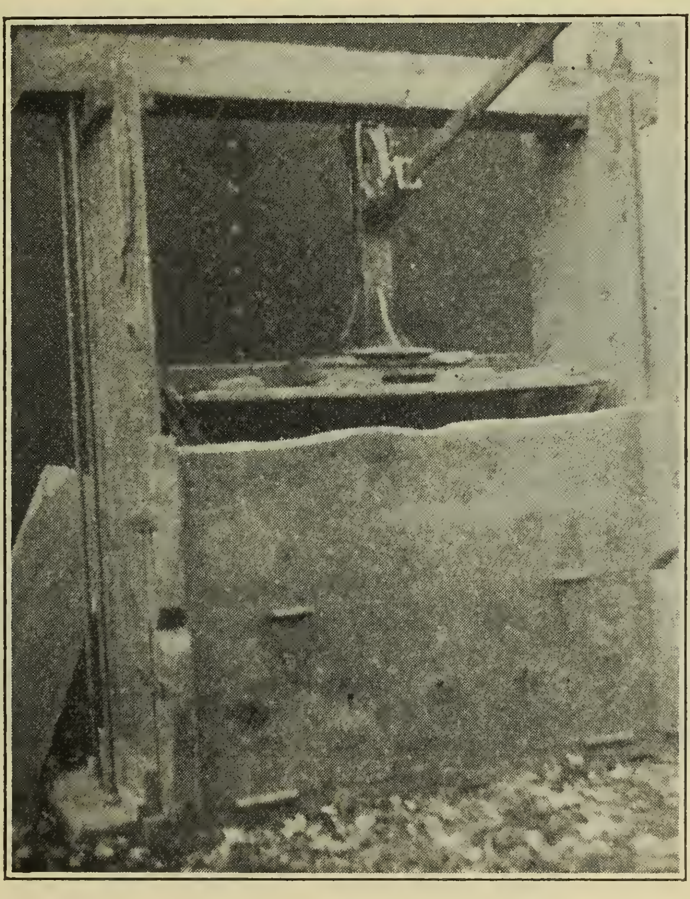

Fig. 25—A home-made baling box.

TOBACCO SEED GROWING

Experimental evidence goes to show that plants grown from seed produced in Ontario are superior to plants grown from seed produced in the South. It is often advisable for the grower to make a selection of plants in his fields and to save seed. By so doing, he may be able to develop a strain of tobacco, which would give him plants ready for planting earlier than otherwise and also plants which might mature earlier, grow more uniformly and produce a better quality tobacco.

In making the selections, the grower should choose a reasonably large number of plants in the first selection. This will enable him to pick and choose until he has eliminated all but the very best and among these latter, there should be combined the qualities which are considered of the highest value.

The plants having been selected should be marked so that they will not be topped with the remainder of the field. When the flower commences to develop, it may be covered with a manilla paper bag or a very fine cotton covering, to prevent cross pollination. In about a week after covering, the bag should be removed, in order to empty out any blossoms which have fallen. All suckers should be pinched off and the stem should remain trimmed down to the main body leaves.

The covering is left on the seed head until the first capsules commence to turn brown. Then the bag may be removed and the head allowed to ripen. When the entire seed head has ripened, it is cut, leaving twelve to fifteen inches of the stalk. The seed heads are hung in an airy barn or building and allowed to thoroughly dry. After drying has been completed, the seed should be shelled, cleaned and stored away for Spring use.

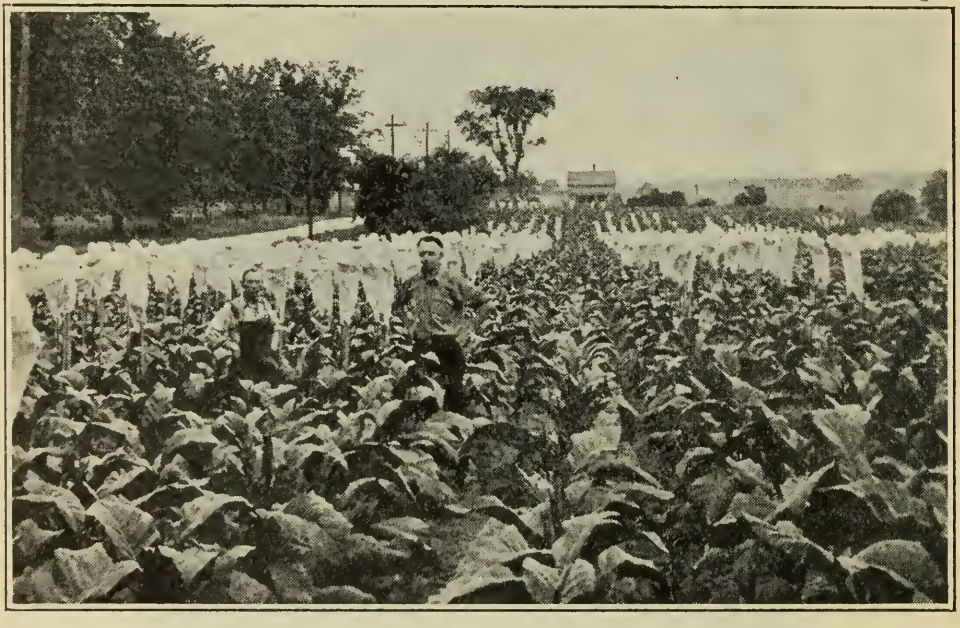

Fig. 26—Flower stalks of tobacco covered for seed production.

DISEASES OF TOBACCO

Mosaic:

Mosaic of tobacco very commonly occurs wherever tobacco is grown. Its presence is noted by a condition of the leaves, which take on an appearance of mottling more or less severe. This mottled appearance has no connection with the similar mottling described as being present in ripe tobacco.

The disease is readily spread from one plant to another and the operations of "Topping" and "suckering" are two of the most common means of infecting healthy plants from diseased ones in the same field.

The inexperienced grower, should he detect anything abnormal in the appearance of his plants, is advised to get in touch with some of the field men working with the Departments of Agriculture, and any of these men will be able to diagnose the trouble for him.

Control Methods are largely preventative. Among others, these are suggested:—

1. Always use fresh soil in the plant beds.
2. Sterilize the seed beds.
3. Practice rotation of crops.
4. Rogue out from the seed beds any diseased plants.
5. Pull diseased plants in the field where it is not too badly infected.
6. Keep the surroundings near the plant bed free from weeds, which may harbor the disease.
7. Do not have the plant beds near a field of growing potatoes.

ROOT-ROT:

Root-rot is a disease, which attacks the root system of tobacco plants, being particularly destructive to the young, fibrous roots. It may develop in the seed bed and may be carried by the plant to the field or it may already exist in fields which have previously grown tobacco.

Fields, which have grown several successive crops of tobacco, or where tobacco has been grown successively in short rotations, are most likely to be diseased. Red clover is known to carry over the disease organisms.

Control Methods:—

1. Practice plant bed sterilization.
2. Practice crop rotation with Red Clover left out of the rotation.
3. Avoid the use of any diseased plants as pulled from the seed bed.

"DAMPING-OFF":

"*Damping-off*" is a disease which attacks young plants of many varieties and it frequently proves very serious with young tobacco plants. Its development is favored in thickly seeded beds and where improper ventilation is provided or where too much water has been applied. The disease is caused by fungus organisms, which usually attack the young plants just at the ground level above the roots and along the stem. The plant at this point rots and breaks off.

Control Measures are preventative rather than curative for, once the disease has commenced its work, it is difficult to save the plants.

1. Sterilize the seed bed.
2. Sow the seed thinly.
3. Provide proper ventilation always.
4. Be careful of the water supply.
5. Do not water late in the afternoon or on dull days.

Should the disease gain a foothold, it might possibly be checked somewhat by cutting down the water supply and increasing the amount of ventilation.

INSECT PESTS

CUTWORM:

The cutworm is probably the most troublesome of all insects that live in the ground and attack the young tobacco plants after being set into the fields. Many poor stands result from the persistent attacks of this pest. The best known method of combating the cutworm is in the use of poisoned bran mash, which is made according to the following directions. The amount, as given, is sufficient with which to treat one acre.

Wheat Bran—50 lbs.
Paris Green—1 lb. or White Arsenic (very finely powdered)—2 lbs.
Molasses—½ gallon.
Water—2 gallons.

Method of Mixing—Mix the bran and the paris green together while still dry. Add the molasses to the water and pour over the mixture, adding sufficient additional water to make the whole mass of a crumbly consistency. The mixture may then be readily spread over the field by hand. Applications should be made after the land has been fitted and made ready for transplanting and not earlier than two or three days before the plants are to be set out. The mash should be applied towards sundown so that it will not dry out before the worms feed. Where cutworms are bad, two applications should be made on succeeding evenings. Once the material dries, the cutworm will not eat it readily.

To make the mash more palatable, finely chopped vegetables or apples may be added to the mixture.

Some growers prefer to put a little of the mash around each plant immediately following transplating. This involves a great deal of labor and so the method already suggested is to be recommended.

Clean cultivation throughout late summer and fall and fall plowing of lands to be cropped the next season, will materially help in controlling the cutworm.

WIREWORM:

Wireworms attack the young plants by boring up through the centre of the stalk and, since the plant often will remain green for some time, it is hard for the inexperienced grower to detect the injury, hence he is delayed in resetting and his crop is, consequently, uneven. This worm, according to species, lives from two to four years in the ground before it is transformed into the adult beetle, which emerges in the Spring of the year. A short rotation of crops is the best method of control. Where old pastures or meadows are freshly broken up and if wireworms are present, it will be best to grow two grain crops, each seeded to clover preceding the tobacco crop.

STALK-BORER:

This insect pest has been reported by the Dominion Department of Entomology at Chatham to have been found in considerable numbers in fields of tobacco in Kent County. In some cases, considerable damage is reported to have resulted.

The adults are moths and the larvae are worms resembling somewhat the larvae of the corn-borer. The worms live over Winter in the soil, feeding on the roots of weeds and other plants—then when the tobacco is set out they enter the young plants and bore up through the centre of the stalk.

The only control method recommended at present by the authority, who is studying this pest, is to avoid, if possible, the use of a weedy field of the past season, for the tobacco crop.

TOBACCO HORNWORM:

The tobacco hornworm is the most serious insect pest of the tobacco crop after the plants have attained some size. This is a similar worm to that which attacks tomato plants, and will eat the leaves of tobacco plants. Where uncontrolled, it will do a great deal of damage. Arsenate of lead is the poison recommended. Where it is used in liquid form, 6 lbs. of arsenate of lead powder are dissolved in one hundred gallons of water and this amount should be sufficient to spray one acre of medium size tobacco. If the dust is preferred, use arsenate of lead and some dry, light carrier, such as sifted wood ashes or hydrated lime, the latter in the proportion of two to three times the weight of the poison. The dust may be applied while the dew is on the tobacco.

Commence to spray or dust as soon as the small worms are noticed in numbers.

The arsenate of lead should meet the following requirements. It should contain at least 30% arsenic oxide (As2 O5) and should have not more than one per cent. of free or water soluble arsenic. A higher percentage is apt to burn the tobacco. Calcium arsenate, though a little cheaper, is as yet not to be so well recommended, on account of possible damage to the tobacco leaves.

GRASSHOPPERS:

Usually grasshoppers do not prove to be a very serious pest with tobacco but a knowledge of how to control them may guard against possible attacks.

Dirty fence rows and neglected fields afford a harboring place for grasshoppers and sometimes they attack the outside rows of the field.

Control Methods would, therefore, suggest that the surroundings be kept as clean as possible and late Fall plowing or early Spring plowing will prove effective. Short rotations are also recommended. Should grasshoppers become very numerous a poison bait mixture, as outlined below, is recommended.

Bran—12 lbs.
Sawdust—equal bulk to that of bran.
White Arsenic or Paris Green—1 lb.
Salt—1 lb.
Water—about 2½ gallons.

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

GUELPH, CANADA

THE EUROPEAN CORN BORER

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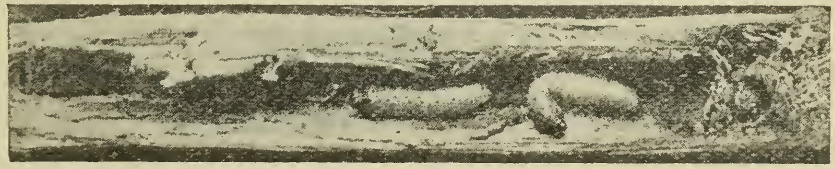
The European Corn Borer (*Pyrausta nubilalis Hubn*), though not discovered in this province until the year 1920, has spread so rapidly and caused so much alarm lest it destroy the corn industry, that it is to-day one of the most common themes of conversation in almost every farm home.



1.—Full grown borers and their work in a corn stalk, slightly reduced; the borers if natural size would be about one inch long. (G. J. Spencer).

Brief Description

The borer (Fig. 1) is a whitish caterpillar with a brownish or often a pinkish tinge. It is about one inch long when full-grown, has a brown head and many small brown spots over its body. The young borers, even when very small, resemble closely the full-grown but are often, when about one-half inch or a little more in length, a good deal darker.

Stages in the Life Cycle

Like most insects the corn borer in the course of its life-cycle passes through four stages—the adult or moth, the egg, the larva or borer, and the pupa. The moths lay the eggs from which the larvae come; the mature larvae transform into pupae; and the pupae into the moths, thus completing the cycle.

Origin

There is no definite knowledge of how the insect was introduced into Ontario or even into the United States, but there is good reason to believe that it was brought into both countries in broom corn imported from Europe. A shipment in 1909 or 1910 from mid-Europe to a broom factory at St. Thomas was probably the means by which it first reached this province.

PRESENT DISTRIBUTION

The borers were not discovered in Ontario until the year 1920. By that date they not only had become very numerous in the territory between St. Thomas and Lake Erie but also had spread out thinly all over Elgin County and a considerable part of all the immediately adjoining counties. There were, moreover, a few more or less isolated infested areas in Huron and Welland. Since 1920 the insect has continued to spread at a very rapid rate—sometimes more than fifty miles a year—and is now (spring of 1928) in practically every part of Ontario where corn is grown to any extent. It has even reached as far north as New Liskeard and as far west as Manitoulin Island. In addition a large part of south western Quebec is infested.

In the United States the spread has been just as rapid. At present the borer not only occurs in Massachusetts and several other adjoining Atlantic States but is also widely extended through every state bordering on the upper part of the St. Lawrence river and the great lakes from Vermont in the east to almost the northern boundary of Michigan on the west.

From what has already taken place and from a knowledge of its range in Europe and Asia there seems almost no doubt that it will not cease to spread until it is present in every part of North America where corn is grown.

HOST PLANTS

In Ontario the only plants on which the insect lays its eggs freely and the larvae mature in large or considerable numbers are corn of all kinds, sorghum, and hemp. Sorghum is not nearly so heavily infested as corn, apparently because the young borers find it difficult to enter the stalks. There is very little hemp grown in Ontario but in Lambton County last year (1927) a hemp field had several thousand borers in it, probably as many as there would have been in a field of sorghum of the same size and in the same locality.

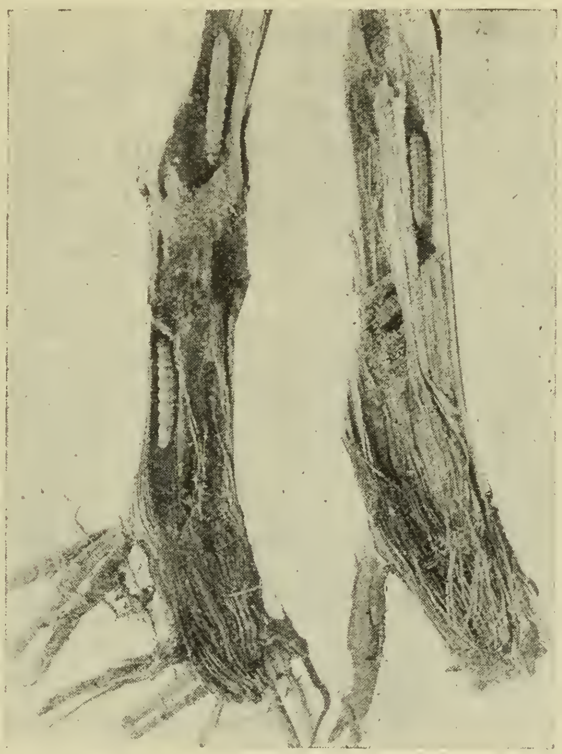
Eggs are laid to some extent also upon oats, barley, gladioli, dahlias, zinnias, thorn apples, sugar beets and beans. In the case of oats and barley the plants ripen before the borers mature and so the latter perish unless they manage to reach stout weeds nearby. On gladioli, dahlias and the other plants mentioned the total number of borers which reach maturity is so small as to be almost insignificant.

The indications are, therefore, that so long as there is corn nearby the insect will not breed to any appreciable extent on other plants, unless possibly upon sorghum and hemp.

WEEDS AND THE BORER

Many persons on reading what has just been said will reply. "This cannot be correct, because we have found the borers in many kinds of weeds and so they must breed in weeds too."

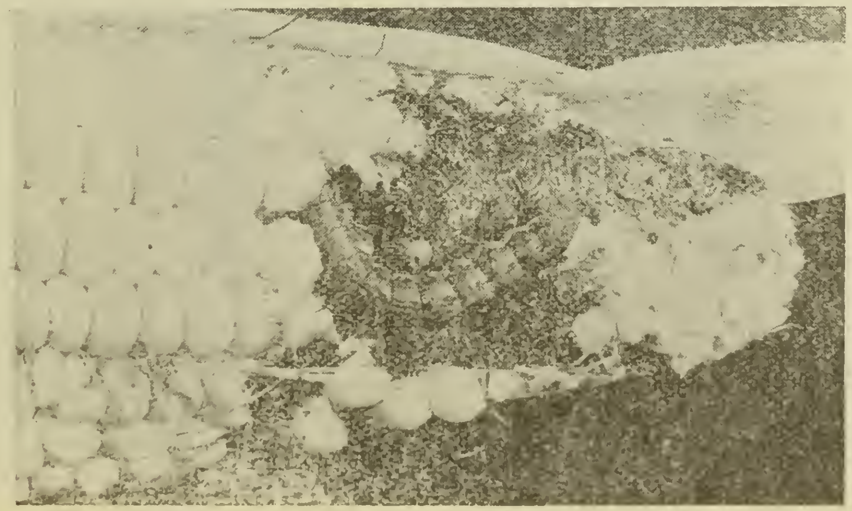
It is true that the corn borer, especially in heavily infested areas, may be found readily in ragweed, pigweed, barnyard grass and almost any weed either among the corn or not farther away than a few feet. Weeds in other crops or growing along roadsides or in waste lands are either entirely uninfested, or so nearly so that no attention need be paid to them. Hence it is the presence of the corn that causes the weeds in or very close to it to be infested. Even then the eggs are rarely laid upon the weeds themselves; for nearly all the borers found in weeds came originally from the corn. A large number of the borers, especially when full-grown, desert the corn plants upon which they have been feeding and after wandering around a while enter either another corn plant or almost any stout weed they meet, and often remain in it over winter. This, then, is the chief way in which the weeds in the corn field become infested, though when a weed is close to a corn plant the moths will occasionally lay eggs upon it.



2.—Borers and their work in stubble. Note that some of this work would be below the ground. (About two-thirds natural size.)

Other Kinds of Borers in Weeds

A great deal of the mistaken belief that the corn borer breeds freely in weeds, no matter where these may be, is due to the failure to realize that there are several other borers besides the corn borer and that some of these breed freely in weeds. For instance, there is one species which breeds in golden-glow, another in columbine, another in iris, another in wild carrot and parsnips and another in smart weed. Then there are still other borers, some of which attack a dozen or more kinds of weeds or other plants, for example; one called the stalk-borer attacks almost any kind of stout plant, whether a weed or not.



3.—Corn ear-worm and its work, natural size. Compare with figure 1.

Most of these borers can be distinguished readily from the corn borer if the two are compared side by side; others are so like it that only a specialist can distinguish between them. It is natural, therefore, for anyone not accustomed to observe insects carefully to suppose, when he finds a borer in a weed, that it is a corn borer.

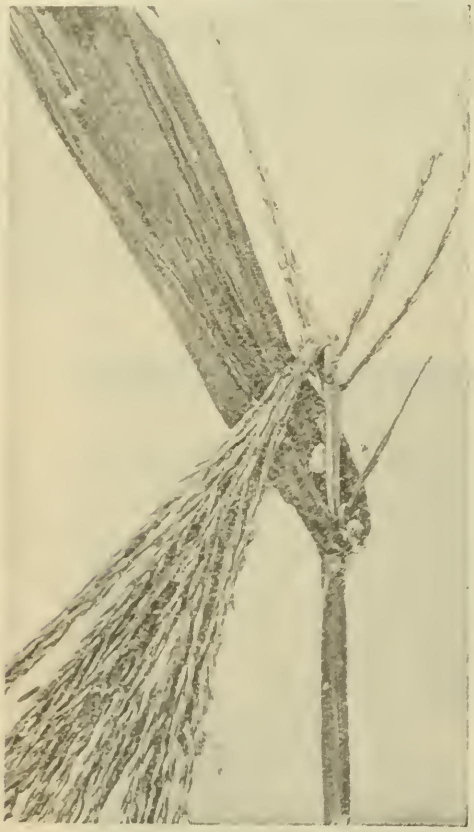
THE CORN EAR-WORM VS. THE CORN BORER

The corn ear-worm (Fig. 2) is an old enemy of corn, which many persons confuse with the European corn borer. Most years it is not numerous enough to attract attention, but occasionally it becomes very abundant and then causes much injury to the ears, especially towards the end of the season. It can be distinguished from the corn borer in the followings ways:—(1) It limits its attack almost exclusively to the upper portion of the ears where it feeds upon the kernels, and unlike the corn borer rarely bores into the cob or stem. (2) It is a much larger caterpillar, being when full grown almost two inches long, while the corn borer is only one inch. (3) The color is different from the corn borer. Most ear-worms are strongly marked with brown or black; a few are greenish or even pinkish; but scarcely any have the whitish or brownish-white nearly uniform color of the corn borer. (4) The corn borer has many small brown spots over the back which are easily seen by a hand lens; the ear-worm has not.

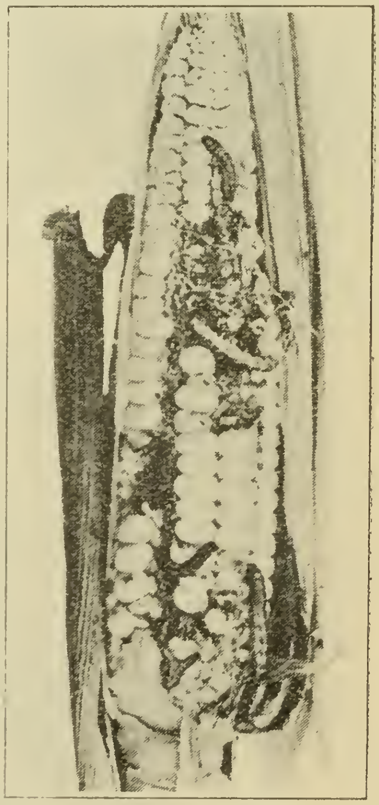
NATURE AND EXTENT OF THE INJURY

The corn borer attacks almost every part of the corn plant—leaf, tassel, ear, stalk and even the thick part of the root below the ground.

The Leaves are slightly injured by the young borers, just after hatching, eating small holes in them; but the chief injury to them is brought about by the larger larvae tunnelling in the midribs, especially where these join the



4.—Tassel broken over by young larvae. Observe the whitish castings at the break and also in the axil of the leaf.



5—Work of borers in corn ear, much reduced. (G. J. Spencer).

stem. This often causes the leaves to break over, dry out, die, and in some cases fall to the ground.

The Tassels are a favorite feeding place for the young larvae and are often soon after expanding so weakened by the tunnels made in them that they fall over or even break off. (See Fig. 4.)

The Ears, especially in sweet corn, are very commonly attacked, the borers entering them from either end or through the husks. Once inside they feed upon the kernels and eat out small or large areas, thus making sweet corn unfit for table use and lessening the yield of husking corn. (See Fig. 5.) Often rain and disease organisms enter through the borer holes and produce rots or moulds, which may destroy even more of the grain than the borers. But the worst injury to the ears is not caused by the borers eating the kernels nor by disease but by the insects attacking the ear-shank or the main stem and thus in many cases cutting off all or nearly all of the supply of food with the result that the ears fail to fill, and so become stunted and shrivelled and of little or no value. Moreover the feeding of the borers in the shank often causes the ears to fall over and even to break off and drop to the ground.

The Stalks are nearly always the part where most borers are found. If the infestation is heavy, so many may enter a single stalk that all the interior will be devoured or so riddled with burrows and filthy with castings and with rot as to be utterly worthless as food for cattle. (See Fig. 1.) Infested stalks are weakened at the point of attack and many of them break over with the wind; in fact, if they are heavily infested, they may break in several places.

Injury Not Conspicuous at First

Many persons on learning that borers can be found readily in any part of their corn field are surprised that the corn does not seem to have been much damaged. The fact is that in the case of ensilage corn very little damage as a rule will be observed until over 50 per cent. of the plants are attacked, but once that figure has been passed the damage increases rapidly until the whole crop may be totally ruined. Sweet corn, however, may be-

6.—Corn field severely broken down and ruined by the borers. (H. G. Crawford).

come unprofitable even when less than 50 per cent. of the plants are attacked, because usually a larger percentage of borers work in the ears of sweet corn and, if even 10 per cent. of these are infested, people will not buy the corn. The work of examining the ears and removing those that are infested takes too much time in most cases to make it profitable.

Description of a Severely Infested Field

A severely infested corn field, such as was common in Essex and Kent in 1925 and 1926 before the Corn Borer Act came into force, is a sickening sight. (See Fig. 6.) Such fields often have from 20 to 50 borers on an average to every plant. The result is that almost every tassell is off; nearly all the leaves have fallen or are hanging down close to the stalk; most of the ears have broken over and when opened are found to be so undeveloped, riddled with borers or rotten as to be worthless; the stalks in many cases have fallen down and formed a tangled mass, or, if still standing, are bare and brown. The result is that the whole field looks somewhat like a spruce forest after a fire has run over it. Any one who has seen such a field will not doubt the power of the borer, if not controlled, to destroy the corn industry.

Damage in Essex and Kent

Perhaps the most convincing proof of the insect's destructiveness is that in six years from the discovery of the first borer in Essex the corn acreage of that county has been reduced from 81,256 acres to 20,214 and this almost solely because of the borer. The reduction in Kent has been almost as large as in Essex.

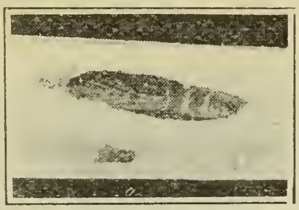
Cause of the More Rapid Increase in Essex and Kent Than in the Rest of the Province

The methods of handling corn in Essex and Kent until this year (1927) have been much more favorable for the rapid increase of the borers than the methods practised in any other county in the Province. In Essex and Kent the old practice, with a good many exceptions, was not to cut the corn but merely to drive through it, break off the ears, haul them away and husk them. Then in spring the corn stalks were disced and the ground well worked up and sowed without ploughing. This left the borers in the stalks and weeds on the surface, and thus gave them almost ideal conditions to survive. But in the other counties the practice has been to cut all or almost all of the corn, and either ensile it or feed it whole, thus killing most of the borers. Moreover the majority of the corn fields are ploughed before the next crop, and this too destroys many borers. It is for this reason then that the borers, though increasing rapidly all over the province, have not increased nearly so rapidly in the rest of it as in Essex and Kent.

LIFE HISTORY

Method of Wintering

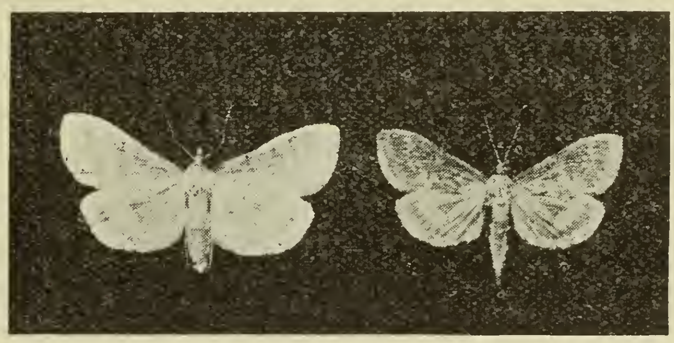
The corn borer passes the winter as a mature larva in any part of the corn plant where it has fed or hidden after ceasing to feed, and also in coarse weeds in or alongside the corn field. Hence if the corn is all left in the fields, as sometimes it is, the borers will all be there too. If, however, it is cut and the stalks are hauled away, any borers in these will also be taken with them and will remain in them unless killed by being put into the silo, fed to cattle, shredded, burned, or buried deeply in manure. The remainder of the borers will be left in the field in the stubble—sometimes as low as the tap root goes,—and in the other corn remnants and weeds.



7.—Pupa in corn stalk, natural size. (J. Marshall).

PUPAE

Late in May or in early June the borers, wherever they happen to be, begin to change into pupae. The pupae are brown, about two-thirds of an inch long and cigar or shuttle-shaped. (See Fig. 7.) Some larvae pupate much later than others but practically all will have done so in a normal season by about the 20th of June. The pupal stage lasts about two weeks and then the moths begin to emerge.



8.—Corn borer moths—female on left, male on right, natural size. (J. Marshall).

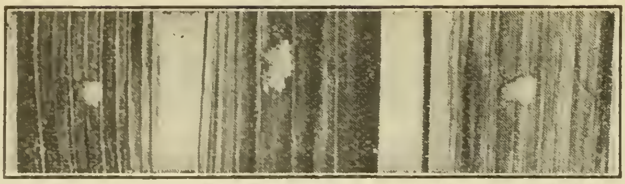
ADULTS

The earliest moths in Essex and Kent usually begin to appear about the middle of June and in other counties one to two weeks later. Moths continue to emerge for a month or more but under normal conditions they have all or almost all appeared by the end of July. A cold, backward season, of course, tends to delay both pupation and the emergence of moths.

The moths are of the size and shape shown in figure eight, the females being a little larger and lighter colored than the males. Very few people ever see the moths, as they do not fly by day. Even if they did see them, they could not be sure they were corn borer moths, as there are several other common species of about the same size and color. The females vary in color but are generally cream-colored or a very light yellow with brownish markings on the wings. The males are darker, being a light brown with creamy markings on the wings.

During the daytime the moths hide among the corn plants or other dense vegetation nearby and late in the evening and at night come out to feed, mate and lay eggs. The only food they seem to require is water, and this they get from rain or dew. They can fly for long distances and have been known to travel in this way at least twenty miles, though probably most of them do not go more than one or two miles. They have a wonderful instinct to spread out and not concentrate in one place; hence, when a locality is even lightly attacked, the infestation will usually be nearly uniform in all the fields, if these have been planted about the same time.

It is not known how long the moths live under natural conditions. The length of time is doubtless influenced greatly by the weather and depends to a great extent upon whether they can get water to drink; for without it they die in about three days. Both sexes have been kept alive in cages for a month or more but observations on the rate of egg-laying in the field would indicate that the average length of life in the open is probably not more than ten days.



9.—Three clusters of eggs each on a piece of corn leaf, about natural size.

EGGS

Egg-laying begins in from 2 to 9 days after the moths have emerged. The eggs are white but before hatching turn nearly black. They are circular, flat and are laid in small clusters of from 3 to 100 or more. (See Fig. 9.) The average number in a cluster is about 18. The total number of eggs laid by a female is not known but probably averages about 300. In cages the average is about 500. Nearly all eggs are placed on the underside of the corn leaves near the midrib, where they are protected from the direct rays of the sun. They are almost all fertile and hatch in 3 to 9 days, depending chiefly upon the temperature.

LARVAE

The larvae on hatching are very small, only about one-sixteenth of an inch long. They usually feed at first upon the leaves, eating small holes in them, and then work their way down to the main plant and there do the injury described above. About 30 to 40 days are required for the development of a larva. This means that in an ordinary season many of those which hatched early would be mature before or by the end of August, and the rest early in September. But if the season is cool and backward, some will not be full-grown until the end of September. Of course they mature earliest in the warmest parts of the province, as in Essex and Kent.

NATURAL CONTROL

The most striking way in which nature helps us is by the destruction of a large number of the very young larvae before they are able to work their way into the corn plant and thus find shelter. Every year from 70 to 90 per cent. of these perish. All the causes of their destruction are not known but some are destroyed apparently by excessive evaporation of their body moisture, due to hot, dry weather; others are knocked off the plants by high winds or washed off by rains and perish either because of the heat of the ground or their inability to find a plant upon which they can enter and feed.

In addition to the great mortality of young larvae just mentioned a considerable number of those left are later destroyed either in the larval or other stages by ants, ground beetles, ladybird beetles, birds, a few native parasites and unfavorable winter conditions.

Yet in spite of this large mortality due to natural agencies the insect is still capable of increasing at such a rapid rate that none but very thorough measures on our part can hold it under control.

IMPORTATION AND REARING OF PARASITES

Since the corn borer is an imported insect and since its native enemies in Europe or Asia have not been imported with it, many people think that the simplest and most satisfactory way of combating it would be to introduce these parasites into Ontario, breed them in large numbers and then free them in the infested areas. This is being done. Through the kindness of the United States Bureau of Entomology several of the most important European parasites have been presented to the Dominion Entomological Branch. These are being reared in large numbers at Chatham and more than 3,000,000 have already been freed in the corn fields. But so far they have had no appreciable effect upon the borers nor is there any proof that they will ever succeed in controlling them. They certainly are not likely to help us much for a good many years yet, and in the meantime the corn industry would be ruined unless other measures for its protection were adopted. Even in Europe the parasites are not able to keep the insect under control without the aid of other measures such as are recommended below. Some day, however, we hope that these parasites and others that may be brought in later will, as in Europe, help to make control easier than it is now.

CONTROL MEASURES

All efforts to control the borers both in Ontario and in the United States by sprays, dusts, light traps or baits have so far been a failure. The methods given below are the only effective ones known. These are based upon two facts:—first, that the borers remain all fall, winter and spring in any part of the corn plant above ground large enough to conceal them and also to a considerable extent in weeds in the corn field; and second, that we can kill them in these by ensiling, feeding, shredding or burning the corn stalks or pieces of stalks and cobs, and by ploughing under completely and keeping under the corn stubble, weeds and debris.

1. *Cutting the Corn.* Corn should be cut as low as possible; for the lower it is cut the fewer the borers left in the stubble, and the easier the ploughing under of the stubble and debris. Hence set the binder as low as it will work, or use one of the low-cutting attachments for binders, which can be purchased from several of the agricultural implement manufacturers. If the acreage is not large, use a heavy, sharp, short-handled hoe.

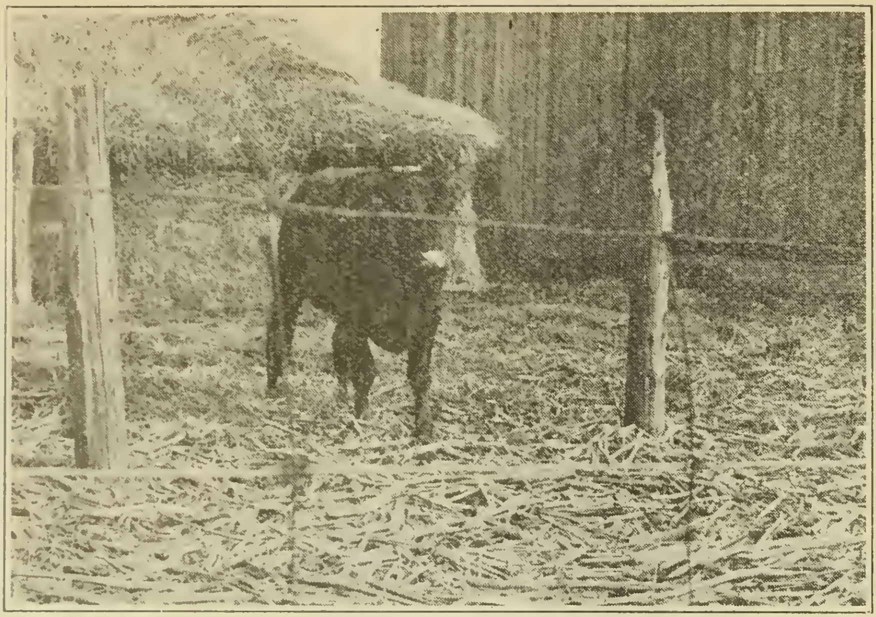
2. *Disposing of the plants after cutting.* These may be disposed of in one or more of the following ways.

(a) By ensiling them. No borer can live long in the silo.

(b) By shredding them. The shredder, if a good one, kills many of borers at once and so crushes the remainder that they almost all die later.

(c) By running them through a cutting-box and feeding them to live-stock. The cutting-box kills many but by no means all of the borers. Therefore any corn thus treated, which is left over in spring, must be hauled out and ploughed under.

(d) By feeding the plants whole. The borers in the consumed parts, of course, perish but many parts of the stalks are left unconsumed. Hence these are a menace. The best way to deal with these remnants is not to throw them out into the manure but to pile them by themselves and later haul them out and burn or plough them under. If, however, they are thrown into the manure and becomes scattered over the barnyard, the top foot of the manure and also all pieces of corn stalks in the rest of the barnyard (see Fig. 10) should be hauled out in spring after all feeding of corn has ceased and either ploughed under carefully or piled neatly, covered with at least 6 inches of earth and left until needed as fertilizer. The reason for removing only the top foot of the manure from the barnyard is that all the borers deeper than one foot will either have perished by the above date or have migrated into the top foot.



10.—A dirty barnyard, harboring many borers. These stalks and corn remnants must be gathered and burned. (G. J. Spencer).

If the corn stalks have been fed whole in a field, paddock, or lane, the remnants in these places too should be gathered and burned or ploughed under or placed in the same pile as those from the barnyard, and of course covered with earth.

(e) By burning all corn stalks left over in spring in stooks in the field or along fences, or in barns or sheds or elsewhere.

3. *Disposal of standing corn from which the ears have been removed and which is not required for fodder.* Usually the simplest method is to break off the stalks on a frosty day in winter or spring, when there is no snow, by hauling an iron rail or planker or heavy piece of timber over the field; or to cut them off with a hoe, or with a mower in spring. Whichever of these methods is followed, rake up the stalks while dry and burn them at once, re-raking and burning if many were left ungathered the first time.

Possibly a more satisfactory plan, if the stalks were dry enough to burn, would be to cut them in the fall as low as possible, then to rake and burn them; for this would give a good chance to plough the field in the fall. It is seldom, however, that the corn, unless very ripe, can be burned in fall without a great deal of work.

Some farmers cut the corn in the fall, stook it in rows, and then plough between these rows. In spring they burn the stooks where they stand and plough the rest of the land. This, however, is a slower method than those recommended above.

4. *Disposal of unshelled ears and cobs.* All unshelled ears should, if at all possible, be shelled in winter or spring, or, if this is not possible, should be kept in a crib covered with wire screening of 20 meshes to the inch, so that the moths in emerging may not escape. All cobs, wherever they may be, should be gathered and burned. (See Fig. 11.)

5. *Disposal of stubble, corn remnants and weeds in the corn field.* All these may be disposed of by ploughing them under completely, and taking precautions not to drag them up later when working the soil or sowing the succeeding crop. If, however, any stubble or corn remnants are dragged up they must be gathered and burned. otherwise many of the borers will not be destroyed.

11.—Corn cobs left lying around the barn or corn crib. These contain borers and must be gathered and burned or ploughed under completely. (G. J. Spencer).

TIME LIMIT FOR ALL THE ABOVE CLEAN-UP OR CONTROL MEASURES. All should be completed by June 1st, otherwise the moths will soon begin to appear and lay their eggs on the new corn plants. The date set in the regulations under the Corn Borer Act is May 20th. This earlier date in such counties is necessary so that the inspector may not be hampered in enforcing the law.

How Ploughing Kills

In considering this subject we should keep in mind that under natural conditions the borers are always on the surface of the soil, never below it, except where they have worked their way down the corn stalk into the tap root; and that they are always concealed in pieces of the corn plants or in weeds or some other good, moderately dry, well ventilated shelter. Therefore when ploughed down they are put under unnatural conditions. For a while at first, being inside the pieces of corn or other similar hiding places, they do not feel the change, but if the soil is warm and moist most of them gradually become restless and work their way up to the surface. Here they seek for pieces of corn or weeds to enter so that they may once more be under natural conditions. If they find them they survive, but if the ploughing has been well done and the stubble and debris has not been dragged up later, they perish, apparently as a result of the attacks of birds, ants, ground beetles, or exposure to the weather.

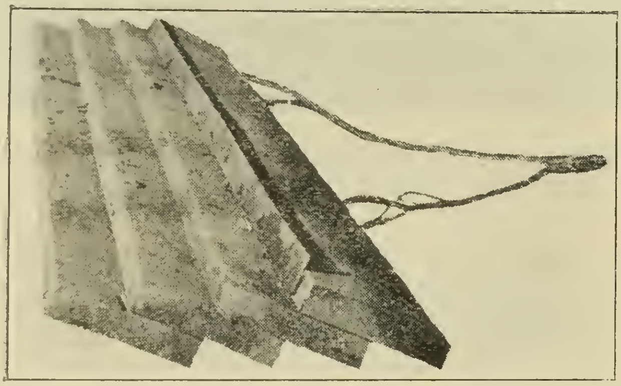
The rate at which the borers, after being ploughed under, migrate back to the surface varies greatly. If they are buried early in fall and the soil is warm and moist most of them will come up in a few weeks. The same is true if the ploughing is done in spring. But if it is done in late fall the migration is usually slow, and many will not come to the surface until the next spring.

There are, some conditions, not yet fully understood, under which a considerable number of the borers do not return to the surface but remain underground. Where this takes place they almost all either perish before they reach the moth stage, or if they live and transform into moths, these either are unable to work their way up through the soil or, if they succeed in doing this, are so injured in the process that they are unable to fly and hence are practically harmless. So that in this case also the ploughing is effective.

It will be noticed, however, that the efficiency of ploughing depends upon the thoroughness with which the stubble and debris are buried and upon not dragging these up to the surface later when working the soil or sowing the next crop. Too much stress cannot be laid upon these points, because by careful attention to them the farmer can do his share easily in combating the corn borer, whereas if he neglects them he will have the tedious and unpleasant task of picking up and burning the stubble and other corn remnants left on the surface or dragged up to it.

Aids to Thorough Ploughing

In order to make it possible and easy to plough stubble and weeds under completely we strongly advise that the corn be cut as low as possible and that in addition a heavy roller or a weighted light roller or a four-board planker (see Fig. 12) with an iron bar, fastened on the rear of the first plank and allowed to project about three-quarters of an inch below it, be run, first one way then back the other along the stubble rows. Either of these implements will crush the stubble and so make it easy to bury. Moreover they will sometimes kill as high as 30 per cent. of all the borers present. The roller works best on light sandy soil, the planker on firm or heavy soil. Double discing lengthwise of the rows, especially with a tractor



12.—Planker, 10 feet long, which may be made of 2 inch planks 8 to 10 inches wide. Note that the planker is upside down to show the strip of iron projecting from the rear of the first plank. The planker is an excellent device for crushing stubble on clay or hard ground but must be run both up and down the rows to do efficient work. (J. Marshall).

13.—Stubble crushed by planker. (J. Marshall).

disc, is also a good preparation for ploughing, especially if the stubble is long or if there are many pieces of stalks on the field.

The ploughing should always be done lengthwise of the rows, never crosswise.

A wide-furrow plough should be used; for a narrow plough sets the earth up on edge and so does not bury the stubble completely. The plough, if a walking one, should be equipped with a straight or knife coulter and a skimmer, but if a tractor, with both rolling coulter and skimmer.

If there is much trash to be buried a chain should also be used, or a stout wire about 8 or 10 feet long attached just above the wing of the skimmer and allowed to drag in the furrow.

Precautions should be taken to run the last furrow before the stubble row, as close to the row as possible, so that the plough on the next round will throw the stubble flat into the furrow and bury it completely.

A depth of five or six inches is satisfactory for a walking plough and six or seven inches for a tractor. See Fig. 14.)

14.—Clean ploughing of corn stubble. The stubble in this field was stout and 6 inches high. It was broken by running the planker both ways over it and then was ploughed 6 inches deep in November with an ordinary wide-furrow walking plow with straight coulter and skimmer. (J. Marshall).

We advise ploughing in the fall, if possible, rather than in the spring; but ploughing should never be done when the ground is very hard and will break up in lumps with the result that the stubble and weeds will not be well covered.

Working the Soil After Ploughing

As already mentioned it is very important not to drag up the stubble after ploughing, for if this is done many of the borers will be able to escape destruction. The best way we have found to prevent the dragging up is to roll the field in spring before working it. This drives down stubble that has heaved and firms the soil so that the stubble or other pieces of corn do not drag up so easily. Then use a disc—never a toothed cultivator—to work the soil and, if at all possible, sow only with a disc drill. If the other kind of drill has to be used, set it to sow shallow.

Ploughing Under Standing Corn

Many farmers would like to plough under their corn stalks without cutting them, because this would, if well done, save them a good deal of work and at the same time supply considerable humus to the soil. Unfortunately only very short, or poorly developed corn can be buried completely by the ordinary farm plough. There are, however, new, specially designed tractor ploughs with 16 or 18 inch bottoms which can bury quite satisfactorily almost any height of corn. Up to the present there are very few of these ploughs in Ontario.

If sweet corn is ploughed under this should be done at once after it is harvested, for it rots much faster when green.

Small Garden Plots of Corn

In every town and village, and also in the suburbs of cities and on many farms there are little plots of table corn varying in size from one or two rows 20 feet or less in length up to half an acre. These are often much more heavily infested than field corn, because they are commonly planted earlier, and usually the earlier the corn, the larger the number of borers in it. These plots are therefore a prolific source of borers and should be cleaned up each year. The simplest method is to leave them until spring then pull all the stalks and also the stout weeds among or near them and burn them. After this is done spade or plough the land.

Late Planting in Heavily Infested Area

In heavily infested areas it is wise, until the borer has been under good control, to plant most of the corn as late as possible without risking failure of the crop. Late corn, especially if planted after about the 5th or 10th of June, is rarely much infested.

Since the borers tend to concentrate in early corn it stands to reason that if a few rows along one side of the corn field are planted early, say May 15 to 25th, this would help to save the later planted main crop. Special care, of course, should be given to destroying the borers in the trap rows. This can be done by cutting such corn early in August while still green and feeding it to cattle.

The Corn Borer Act

As the corn borer can only be controlled by everybody in an infested area co-operating and destroying the borer on his own farm, and as many farmers for various reasons will not voluntarily do this, the Corn Borer Act, at the request of corn growers and others who saw the need of it was passed. This Act makes it compulsory for every farmer to clean up his own corn field and destroy the borers on his own place. If he fails to do so he can be fined or men may be sent on his farm to do the clean-up work and the cost added to his taxes. Inspectors are appointed to see that the Act is enforced. Half of their expenses is borne by the department and the other half by the county.

The Act came into operation for the first time in the fall of 1920, but was limited that year to the counties of Essex, Kent, Lambton, Elgin, Middlesex, Norfolk, Oxford and Prince Edward. In the fall of 1927 it was extended to all the territory from Goderich to about 8 miles north of Toronto and for a few miles back from Lake Ontario all the way east to the farther boundary of Hastings. There seems no doubt it will gradually have to be extended until it takes in all the corn growing parts of the province.

Will the Act Result in Control of the Borer?

One year's operation of the Act is not sufficient to determine what can be accomplished but the fact that the first year's operation even under what would seem to have been unfavorable conditions resulted in an average reduction of over 30 per cent in the number of the borers in the counties of Essex, Kent, Elgin, Norfolk and Oxford, is very encouraging. If a further reduction can be made in 1928 we shall feel certain that we can control this great enemy and save the corn industry. There may be years specially favorable to the insect when we shall make no headway, but in other years less favorable to it, we hope to make good progress.

It must always be remembered that the success of the Act depends upon the thoroughness with which it is enforced. Therefore every corn grower, instead of finding fault with the inspector for being too strict, should encourage him to enforce the law without fear or favor.

The writer is hopeful that every farmer gradually will learn the best way to destroy all corn remnants on his farm and to plough and work his corn field in such a manner that no stubble will be dragged up. Once this is brought about there will be little or no complaints of hardships from the Corn Borer Act but only hearty approval of it.

SUMMARY OF THE CONTROL MEASURES

1. Cut low or break off all corn stalks.
2. Destroy all the borers in the stalks and ears by ensiling, feeding, shredding or burning.
3. Destroy all left in the field in the stubble, weeds or debris by plowing these down completely.
4. Avoid dragging up the stubble when cultivating. Hence do not use toothed implements, but a disc, and sow the field with a disc drill.
5. Have all the above control measures completed before June 1st.
6. In heavily infested areas plant most of the corn as late as possible without risking failure of a crop.

ACT AND REGULATIONS

THE ACT

R.S.O. Chap. 312, 1927

1. In this Act,—

(a) "Corn borer" shall mean the insect known as the European corn borer;

(b) "Regulations" shall mean regulations made under the authority of this Act.

2. The council of a county, city or separated town may, and upon notice in writing from the Provincial Entomologist, shall by by-law provide,

(a) for the appointment of an inspector for the purpose of eradicating the corn borer;

(b) for fixing the remuneration and expenses to be allowed to any inspector so appointed.

3. The Provincial Entomologist of the Department of Agriculture shall furnish assistance and co-operation to any inspector appointed under this Act and shall instruct the inspector in the methods to be adopted for controlling and eradicating the corn borer and the inspector shall adopt only such methods as are approved of by the Provincial Entomologist.

4. Every inspector appointed under this Act shall have authority to enter upon any premises where he has reason to believe that the born borer exists and shall give such advice and instruction to the owner or occupant of such premises as to the methods to be adopted to control and eradicate the corn borer as the inspector may deem necessary and as may have been approved by the Provincial Entomologist.

5. Where such premises are unoccupied or the owner or occupant neglects or refuses to carry out the instructions of the inspector, the inspector may, by himself, or with such assistance as he may deem necessary, carry out such measures as may have been approved by the Provincial Entomologist for the control and eradication of the corn borer on such premises and he shall certify any expense so incurred to the clerk

of the municipality and the amount shall thereupon be entered on the collector's roll and be collected in the same manner as other taxes.

6. The municipal corporation shall pay to the municipal inspector such compensation as may be agreed upon or as may be fair and reasonable and his reasonable travelling and other expenses in the performance of his duties under this Act and upon furnishing to the Department on or before the 15th day of December in each year a statement of the amounts so paid, certified by the Provincial Entomologist, and the corporation shall be entitled to receive from the Department one-half of any amount so paid during the twelve months next preceding the said date.

7. Every person who,—

(a) refuses or neglects to carry out the instructions of the inspector; or

(b) obstructs the inspector in the performance of his duty

shall on summary conviction incur a penalty of not less than $10 nor more than $50 for each offence and such penalty shall be in addition to any other costs and expenses to which the offender may be liable under this Act.

8. The Minister of Agriculture, with the approval of the Lieutenant-Governor in Council may make such regulations as may be necessary for the better carrying out of the provisions of this Act.

REGULATIONS OF MINISTER OF AGRICULTURE

1. It shall be the duty of every person growing corn in the counties in which the corn Borer Act has been made effective to adopt such methods in the growing of corn and in handling the land and the remnants of the crop as will most effectively control the corn borer; and all persons growing corn shall be responsible for giving effect to the provisions of the Act and Regulations whether owners of the land or not.

2. All corn stalks, pieces of stalks and cobs of each year's corn crop, whether in the field, barn or elsewhere, shall, if not fed, or ensiled, or shredded or mixed with manure, be destroyed by burning or by ploughing under completely, or by a combination of burning and ploughing.

3. Wherever corn stalks, or pieces of stalks, or cobs are mixed with the manure, the top eight inches of the entire surface of the manure shall be removed and burned, or ploughed under completely, or piled in a heap and the heap at once thoroughly covered to a depth of four inches with earth or well-rotted manure, free from corn stalks, or any coarse plants or parts of plants capable of affording a hiding place for the borers. This covering shall remain intact until at least July 1st.

4. All shelled corn and corn-on-the-cob shall be stored in a perfectly dry place after May 20th. Hence all such corn if in a crib or other exposed storage shall be transferred by the above date to a barn or granary.

5. All corn stubble shall be ploughed under completely and proper precautions shall be taken not to drag up to the surface this or other buried corn remnants or weeds when cultivating the soil or planting the succeeding crop. If, however, any are dragged up, they shall be gathered and burned within ten days.

6. No person or persons shall plant wheat or any fall or spring crop in a field in which the immediately preceding crop was corn until all the remnants of the corn crop on the field have first been disposed of in accordance with the above regulations.

7. These regulations shall apply to land not being used for immediate cropping as well as to land being so used, and all control measures shall be completed not later than May 20th, of the year succeeding the corn crop.

8. Whenever the inspector on examination finds that any of the above Regulations has not been complied with, he shall at once take such action as may be necessary for the destruction of the borer.

9. Any prosecutions for violation of the Act or regulations shall be made under The Ontario Summary Convictions Act.

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BULLETIN No. 335 APRIL 1928

Ontario Department of Agriculture

HORTICULTURAL EXPERIMENTAL STATION
VINELAND STATION, ONT.

The Strawberry in Ontario

E. F. PALMER and W. J. STRONG

INTRODUCTION

The strawberry is found wild in Canada from coast to coast. Cultivated varieties are equally widespread. The strawberry is by far the most important of the small fruits grown in Canada the value of the crop being considerably in excess of that of all other small fruits combined. Ontario leads the provinces in production with over seventy-two percent of the total. British Columbia comes next with eleven per cent, with Quebec and the Maritimes making up most of the balance (Dominion Census of 1921).

View of a large strawberry patch in Norfolk County.

In assembling the information contained in this bulletin, and dealing with this important small fruit, the thought in mind has been to present a practical outline of strawberry growing in Ontario. The information presented has been gathered from several sources, more particularly from the personal experience of the writers, from various publications, and from representative growers in the several recognized commercial strawberry growing areas of the province. To these latter especial thanks are due for the careful filling out and returning of the questionnaire sent them.

While the strawberry is found wild and is cultivated over a great part of the North American Continent, yet it is generally recognized that the cultural requirements of this fruit may vary greatly under differing environmental conditions. Therefore details of culture will often require to be worked out by individual growers to meet their particular conditions. It is hoped that the following pages will serve as a help and guide particularly to growers of limited experience. Experienced growers also may find some information of value.

ORIGIN AND HISTORY OF CULTIVATED VARIETIES*

The strawberry is found in one species or another in almost every part of the globe. Essentially however it is a lover of cool climates thriving best and being most appreciated under such conditions. "In tropical and sub-tropical countries, the plants grow but languidly, refuse to bear abundantly, and the fruits are deficient in size, color, flavor and the delicate fragrance from which the strawberry derives its generic name "*Fragaria*".

"The strawberry has but lately come under cultivation. . . . Its history dates back scarcely more than four centuries in French and English gardens. After the currant and gooseberry, however, it has been longest cultivated of small fruits in North America, where it has been grown in gardens perhaps two centuries and in commercial plantations about a century."

"Several notable botanists and pomologists have studied Fragaria and the history and development of its cultivated offspring assiduously, yet no two arrive at the same conclusions as to the exact origin of the modern cultivated strawberry. All historical evidence seems to have been collected and examined by competent minds, without establishing whether the cultivated strawberry belongs to a single species, and what or whether it is a hybrid and of what." However, the weight of evidence seems to indicate that the modern garden strawberry of North America and Europe is a hybrid between *Fragaria virginiana* and *F. chiloensis*.

Both of the above species are native to America; and since these two species have probably given the world most of its cultivated varieties, the strawberry may be considered preeminently an American fruit. As already mentioned it is the most important of the small fruits in Canada. The same condition holds true in the United States where it also outvalues all other small fruits combined. Notwithstanding this fact, the strawberry industry is of comparatively recent development on this continent, commercial production on a small scale starting soon after the year 1800.

At this time there were several good varieties in cultivation, notably Early Hudson, Hudson's Bay and Early Scarlet. The superiority of these varieties over the wild berries offered for sale soon created a demand in response to which commercial culture began. Improvement in the status of the industry came with improvement in varieties. The introduction of the Hovey variety in 1838 constituted a real landmark. It was the first notable variety in the present race of large fruited strawberries, was rapidly disseminated in the United States, and at first was everywhere received with enthusiasm. As a commercial berry, however, it did not survive any great length of time except in the vicinity of Boston. Its faults were that it required high culture, was a poor plant maker, and was pistillate, thus requiring cross-pollination. As a home garden variety, however, it long retained its popularity.

The variety which eventually transformed the commercial culture of the strawberry from one of small dimensions to an important industry was the Wilson, originated by James Wilson of Albany, N.Y. Even though no effort was made to bring it to public notice, as in the case of the Hovey, the Wilson rapidly supplanted other varieties in practically all strawberry growing areas. It was introduced in

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*The historical information has been obtained largely from "Small Fruits of New York" by Hedrick, et al, from which volume quotations have been freely made, and from "The Strawberry in North America" by S. W. Fletcher. Grateful acknowledgment is made.

1854 and held almost undisputed sway for some twenty years, even though admittedly of poor quality. As a variety it was dependable, producing large crops of attractive fruit even under indifferent care. Also it was perfect flowered, not requiring cross-pollination. "In short, the Wilson simplified the cultivation of the strawberry. Not until then had it been possible for everyone to grow strawberries, the poor as well as the rich. It did not require the services of a professional gardener. The strawberry now became, in fact, a fruit for the millions". (Fletcher, "The Strawberry in North America").

The Crescent, introduced in 1876 offered the first real challenge to the Wilson. By that time the Wilson had begun to lose some of its early vigor and productiveness. A change was in order and the Crescent met the situation. It was very productive and earlier than the Wilson, though inferior even to that variety in quality, and in appearance and size. However it thrived everywhere with a minimum of effort, hence was popular.

In 1877 the Sharpless was introduced. Although falling somewhat short of the Crescent in productiveness, it immediately became a standard variety because of its size and beauty. It was the first of the very large fruited varieties that could be grown without special difficulty. These varieties have now all been superseded by newer and better ones. Nevertheless they played a most important part in the development of the industry.

THE INDUSTRY IN ONTARIO

In Ontario the strawberry began to assume commercial importance about 1865. At that time it is estimated that there were about fifty acres of all kinds of small fruits in the province, the largest acreage being in the Burlington district. In 1869 sixty acres of strawberries were reported in the Oakville district, and with excellent price prospects plantings were increased to two hundred acres. Wilson was the leading variety. Until 1889 prices generally were good and the acreage increased rapidly, but the next ten years were discouraging due largely to a wide-spread trade depression. Following the period of depression there has been a fairly steady growth of the industry which, with minor fluctuations, probably reached its peak during the war years. Census figures for 1921 indicate that there has been a decrease in acreage and production from the figures of the 1911 census. Since 1921 there has probably been a further decrease especially marked in the Burlington and Niagara districts. The actual acreage in the Province at the present time is difficult to determine, partly because it is now about seven years since the last Dominion Census.

While acreage and production of strawberries for Ontario have possibly decreased since the census year 1921 (crop year 1920) it is doubtful if the decrease has been as marked as the accompanying figures would indicate. With the exception of the year 1920, the figures in Table I are from the Annual Report on Fruit Statistics prepared by the Dominion Bureau of Statistics in collaboration with the Dominion Fruit Branch. Figures for 1920 are those given in the Sixth Census of Canada, 1921.

Table I.

Production and Value of Strawberries for Ontario 1920-26

	Production in quarts	Total Value	Av. Price per qt.
1920	10,832,306	1,821,608	.17
1921	5,181,000	725,340	.14
1922	4,755,000	713,250	.15
1923	3,607,200	441,480	.12
1924	3,607,000	468,910	.13
1925	3,800,000	532,000	.14
1926	3,500,000	630,000	.13

The figures, if even approximately correct, are sufficiently startling to require little further comment. Based on yields there would appear to be a tremendous drop in acreage from 1921 on. However a more detailed study of crop conditions for the years 1920 to 1926 reveals the fact that 1920 itself was a particularly heavy crop year, and that no year since, irrespective of actual acreage, has likely approached it in yield per acre. It is evident therefore that the crop production of a single year is not a fair measure of the importance of an industry. Taking one year with another, and including all growers whether good or otherwise, the average yield for strawberries is estimated at 1700 quarts per acre. Undoubtedly the average yield in 1920 was much above this figure, and it is equally evident that there has been a succession of short crops since that time due to unfavorable weather conditions especially during the picking season.

As to actual acreage, provincially compiled figures indicate that there has been no reduction in total acreage for the province since 1921, rather that there has been a slight increase from an estimated 6,670 acres to 7,274 acres. Decreased acreage in the Niagara and Burlington districts has possibly been balanced by increased acreage in other districts. These estimated acreages include all strawberry plantations, the product of which finds its way even to village and small town markets. The acreage of strawberries grown commercially in the main producing areas for the larger and more distant markets, is much below the figures noted, probably less than half.

The Dominion Agricultural Census of 1921 indicates the chief strawberry producing areas of the province. Roughly there are three main strawberry sections, as follows (1) The Simcoe and Waterford districts in Norfolk county and adjacent areas in the county of Brant, (2) The Burlington, Oakville and Clarkson districts in Halton and Peel, and (3) The Niagara District, in Lincoln and Wentworth counties.

TABLE II.
STRAWBERRY PRODUCTION IN ONTARIO 1920.

County		Production	Value
Brant	1	559,642	86,825
Norfolk		2,461,016	369,022
Halton	2	1,258,560	196,192
Peel		1,705,654	299,088
Lincoln	3	990,421	149,056
Wentworth		681,873	113,118
Other Counties		3,175,140	608,307
Province		10,832,306	1,821,608

Over seventy percent of the commercial production for the province is centred in the above six counties. The remaining production is scattered over the province, more particularly in the counties of Elgin, Kent, Middlesex, Prince Edward, Simcoe and Welland.

Because of the ease with which acreage may be increased or decreased strawberry production fluctuates considerably, almost from year to year. A season or two of low returns has an immediate effect on plantings. There is also fluctuation, more evident in some districts than others due to the fact that the strawberry apparently falls off in vigor and productiveness if grown too often on the same soil. Frequent change is necessary. In districts where farms are large and land relatively cheap as in Norfolk county, this is easily accomplished. In other districts as in Burlington and Clarkson, where land is high priced, holdings are small, and cultural methods necessarily more intensive, the maintenance of vigor and yield presents a real problem. The only practical solution so far seems to have been a reduction in strawberry acreage in the older districts, and an increase in adjoining new areas.

Imports of Strawberries from the United States. Acreage of strawberries in Ontario may have decreased, and production certainly has decreased of late years.

There has been no decrease in imports however as the following figures obtained from the External Trade Branch of the Dominion Bureau of Statistics, will show.

TABLE III.

IMPORTS OF STRAWBERRIES INTO CANADA FROM THE UNITED STATES

Month	1924-25	1925-26	1926-27	1927-28
April	79,392	188,908	106,656	215,123
May	1,193,634	1,407,654	913,428	1,541,446
June	2,858,604	1,476,921	2,436,910	3,581,812
July	882,063	68,058	274,008	298,960
August	50,908	937	11,565	110,130
September	660	386	23,936	180,252
October	12,014	369	—	—
November	30,720	629	33,000	226,386
December	12,960	—	35,350	—
January	9,423	192	4,832	—
February	18,062	4,174	6,629	—
March	38,130	20,747	92,893	—
Total	5,186,110	3,168,975	3,939,207	6,154,109
Value	$764,593	$607,345	$667,917	$813,010

These figures are of course for the whole of Canada. May and June are the big importing months. The heavy imports of over 6,000,000 pounds for the eight month period April-November 1927 are much above those of the preceding two years, and almost a million pounds above the high figure for 1924-25. Imports into Canada are greater than the total Ontario production, and these imports are growing, which may account in part for decreased Ontario production.

Exports of Strawberries from Canada to other Countries.

Clearly we are in no immediate danger of swamping foreign markets as the following figures will indicate.

TABLE IV.

EXPORTS OF STRAWBERRIES FROM CANADA 1926 AND 1927.

	1926		1927	
Exported to	Pounds	Value $	Pounds	Value $
United States	484,360	71,998	319,650	47,836
Alaska	896	127	—	—
Newfoundland	65	19	452	91

VARIETIES

The replies received in response to the questionnaire sent out to representative growers, indicated that four varieties only are being grown to any appreciable extent for commercial purposes. These four are Premier or Howard 17, Glen Mary, Parsons and Williams. It would seem that varieties such as Senator Dunlap and Wm. Belt no longer find favor with the commercial grower. Williams also, though included by several growers is undoubtedly losing ground, the more productive Glen Mary and the Parsons taking the place of Williams in the Niagara District where once it was the leading variety.

Yield and ease of culture seem to determine more than any other factors the popularity of a variety. This probably explains the otherwise rather surprising fact that Portia, which has no equal as a canning and jam making berry, is not more widely grown. Portia, because of its imperfect flowers requires more cultural care than perfect flowered varieties, and even where provision is made for cross-pollination the yield may fall short of that of perfect flowered sorts.

In any discussion of strawberry varieties, it is necessary to keep always in mind the fact that most varieties seem to have distinct soil and climatic preferences. Few present day varieties are cosmopolitan in this respect. The Dunlap is one exception, which accounts in part at least for its wide planting. Many varieties, successful in various sections of the United States, have been tried under Ontario conditions and found wanting. In this class would fall Aroma, Gandy, Joe, Magoon, and many others. Conversely, Parsons and Glen Mary, no longer grown extensively in the United States, are our main varieties. And these two do not succeed uniformly in all our strawberry sections. As with practically all varieties, their adaptability is dependent seemingly on some particular condition of soil type, food or moisture supply, and the set of conditions which suits one variety may not necessarily suit another. In selecting a variety or varieties to plant the grower cannot do better than to set out those varieties which have proven successful with his neighbors.

Short descriptions of the four generally grown varieties are given herewith.

Premier or Howard 17. Originated by A. B. Howard of Belchertown, Mass. Introduced in 1909. This variety has rapidly gained favor as an early sort. In the district between Burlington and Hamilton where an early variety is desired it has practically superseded all other varieties whether early or late. In some seasons Premier fails to make a good row and it is seldom if ever an abundant plant maker. In planting therefore plants should be set closer together than with most other varieties. It is vigorous, healthy, perfect flowered, and for an early variety, productive. The fruit, which is of the type of Dunlap, is of medium size, usually conic, and a bright, attractive scarlet in color. The flesh is moderately firm and good in quality. At the present time Premier is our best commercial early variety.

Parsons.

Glen Mary. Originated by J. A. Ingram of East Bradford, Pennsylvania, about 1890. For many years the Glen Mary has been grown to the practical exclusion of all other varieties in the Clarkson district. Until recent years at least it has yielded well there, the soil conditions apparently being much to its liking. Because of its heavy yielding characteristic Glen Mary has spread to the Niagara District, where, along with Parsons, it is rapidly replacing the old Williams. The fruit of the Glen Mary is large, irregular and inclined to roughness but generally handsome in appearance. The flesh is somewhat soft, making long distance shipments difficult. In color the fruit is a medium dark scarlet, while the flesh is a medium red. The plants are large, vigorous, healthy and good runner makers. Especially in the early part of the blooming period, Glen Mary is often an insufficient pollen producer, malformed fruits being the result. Provision for cross pollination would help where this condition occurs regularly.

Parsons. Originated about 1895 by R. G. Parsons of Parsonsburg, Maryland. At the present time the Parsons or Parsons Beauty dominates the situation in the Simcoe and Waterford area in the same way that Glen Mary dominates the Clarkson district. The Parsons is a distinctly better berry for canning and jam-making than the Glen Mary, and is also a better shipper on account of its firmer flesh. These considerations no doubt have counted strongly in favor of Parsons around Simcoe and Waterford as much of the crop there is grown for factory purposes or for distant fresh markets.

Parsons is a good runner maker, vigorous and healthy. It will not, however, stand up under drought as will Glen Mary. If the season be unfavorable, conservation of moisture is all important. Under good conditions it is a heavy yielder. The fruit of Parsons is of good size, irregular-conic to wedge-conic in shape, firm, bright crimson and of good quality. Midseason. Parsons is similar to, if not identical with Gibson and Pocomoke.

Williams. This variety, a cross of Crescent and Sharpless, was originated by a Mr. Williams of Burford, Ontario. It was introduced in 1890. In spite of its objectionable white tip, Williams has long been a favorite with many Ontario growers. Of late years it seems to have fallen off in productiveness and is being displaced by the varieties already discussed. Williams is a very free runner maker; plants large, vigorous and generally healthy. Perfect flowered. The fruit is large, round-conic to wedge-conic, dark crimson; flesh dark red, firm, medium quality.

New Varieties. Several new and promising varieties should be mentioned. Bliss and Bouquet, both originated by the New York Agricultural Experiment Station, show distinct promise as mid to late season varieties. Vanguard and Vandyke (19322), originations of the Ontario Horticultural Experiment Station are worthy of trial as early varieties. The latter, which is now named for the first time, has shown up remarkably well with a few growers to whom plants were sent for trial purposes. One grower reports a phenomenal yield in 1927.

Everbearing Varieties. In the so-called "everbearing" or fall bearing varieties, several may be mentioned, notably Duluth and Mastodon. A paragraph on the culture of these varieties is included later in the bulletin.

LOCATION AND SITE

It is not often perhaps that the question of general location can be considered by the strawberry grower as this is usually determined by the farm already in his possession. It may be ideally suited to strawberries or it may fall short in one or more respects. Where consideration can be given to location however, several important factors should be kept in mind. These are, climatic conditions, marketing facilities, market preferences, kind and condition of soil, natural soil drainage, and labor supply. Frequently one factor is more or less offset by another. For example the Clarkson district is ideally located from a fresh market standpoint. Land however, is high in price. On the other hand the Simcoe-Waterford district, with relatively distant fresh markets, has compensating advantages in low-priced land and a factory outlet for a considerable percentage of the crop.

The immediate site for the strawberry plantation should be selected with care. Apart from the character of the soil, which will be discussed later, good drainage, surface as well as under-drainage is essential. In fact, surface drainage is often more vital than actual tile undrainage, as many strawberry sites are sufficiently ideal as to situation and soil type as not to require artificial underdrainage. Standing water, however, even for a few hours only is always harmful whether during the growing season, or in late winter or early spring. Underdrains are of no value in removing surplus water when the ground is frozen for a time after the early spring melting of snow. Surface drainage must be relied on under such conditions, which means that the site must have sufficient slope and be free of pockets or basins, to permit such drainage. Such a site also will give proper air drainage, essential in districts subject to the late spring frosts.

For early fruit a light soil and a warm southern slope, if sufficiently free from frosts during the blossoming season, is to be preferred. The blossoming season is to some extent under the control of the grower, as it may be delayed by leaving the winter mulch on until the plants actually begin to suffer. For late crops a northern exposure is preferable, and somewhat heavier soils may be used. On such soils, crops are likely to be heavier than on the earlier, lighter, drier soils.

SOILS

" 'The ideal strawberry soil' has been described at various times by various persons. Compiling these descriptions, it is found to vary from almost pure sand to heavy clay or muck. This leads to the conclusion that there is no ideal soil for the strawberry, but that some soils are more desirable than others in certain localities and for certain purposes. Strawberries are grown commercially on almost every type of soil, provided it is well drained and at least fairly fertile, whether the fertility is natural or supplied".*

The truth of the above is evident when one considers the varying character of the "strawberry" soils in the several commercial districts of Ontario. Generally speaking, growers prefer the lighter soil types, rather than the clay or muck soils. But, whatever the soil texture, it is essential that it be high in humus content, in plant food, whether natural or supplied, and in moisture holding capacity.

The lighter soils are more easily worked than the clay soils, and also may be worked earlier in the spring. Both are important considerations. On the other hand the heavier soil types will be found to be correspondingly more fertile naturally, and higher in humus content. They will require less feeding than the light, sandy soils. Incidentally, and of considerable importance, chickweed is distinctly more troublesome on the fertile loams than on the sandy soils. Its control presents no particular problem on most of the Simcoe-Waterford soils. In other strawberry areas, chickweed is a most troublesome weed, difficult if not impossible of economic control. The only effective "control" is to avoid it by planting, if possible, on clean land.

As to the soil factor, then, it may be said that it is decidedly important, for, while the strawberry is successful grown on a great variety of soils, it seems naturally to prefer a deep, warm sand loam that is retentive of moisture. The latter factor is of great importance. Farmyard manure and commercial fertilizers may be applied in large quantities at the will of the grower, but for the water supply, except where irrigation plants have been installed, the grower is entirely dependent on nature. The strawberry crop generally is likely to be a failure to the extent that moisture is lacking during the critical ripening season.

Soil Acidity. It is frequently stated that the strawberry requires an acid soil, and there is ample evidence to show that this fruit will thrive on such soils. On the other hand there is now evidence that strawberries grow and do well on neutral and even alkaline soils. "It follows then that there is seldom occasion for applying treatment to strawberry fields or to land to be planted to strawberries primarily to change the soil's reaction. Ordinarily it is other limiting factors which need corrective treatment in strawberry growing. The popular notion that strawberries are acid tolerant and even "acid loving" is correct. To say that strawberries require an acid soil is erroneous". **

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*S. W. Fletcher, "Strawberry Growing".

**Morris, L. S. and Crist, J. W. "The Influence of Reaction of Culture Medium on Growth of Strawberry Plants".

SOIL PREPARATION AND FERTILIZING

Preparation of the soil for strawberries should begin at least a year, and preferably more, in advance of planting. If the land intended for the strawberries is in grass sod then it should be plowed and cropped for at least two and preferably three years before planting to strawberries, otherwise losses from the ravages of the white grub will likely be severe. Weedy soils also increase the expense of growing strawberries. Hoed crops, as potatoes, corn, etc. preceding strawberries, will help to clean the land up, and will at the same time improve its physical condition, especially if heavily manured.

Many growers follow a fairly regular rotation for their strawberry land. A rotation which seems to find general favor is one consisting of clover, hoe crop (usually potatoes), and strawberries. The plowing down of a good stand of clover is a most valuable practice and one that more growers could follow with profit, particularly where barnyard manure is not available in quantity. It is wise, however. to follow the clover with a clean-up hoe crop, and at the same time to manure heavily so as to get the soil in the best possible condition for strawberries. It is doubtful whether soil can be made too rich for strawberries providing the fertility program is fairly well balanced. Heavy applications of barnyard manure, up to thirty to forty tons per acre, not only increase the fertility of the soil, but materially increase its moisture holding capacity. On clay soils, manure, instead of tending to make the clay heavier as it does the sand, makes it lighter and more easily handled.

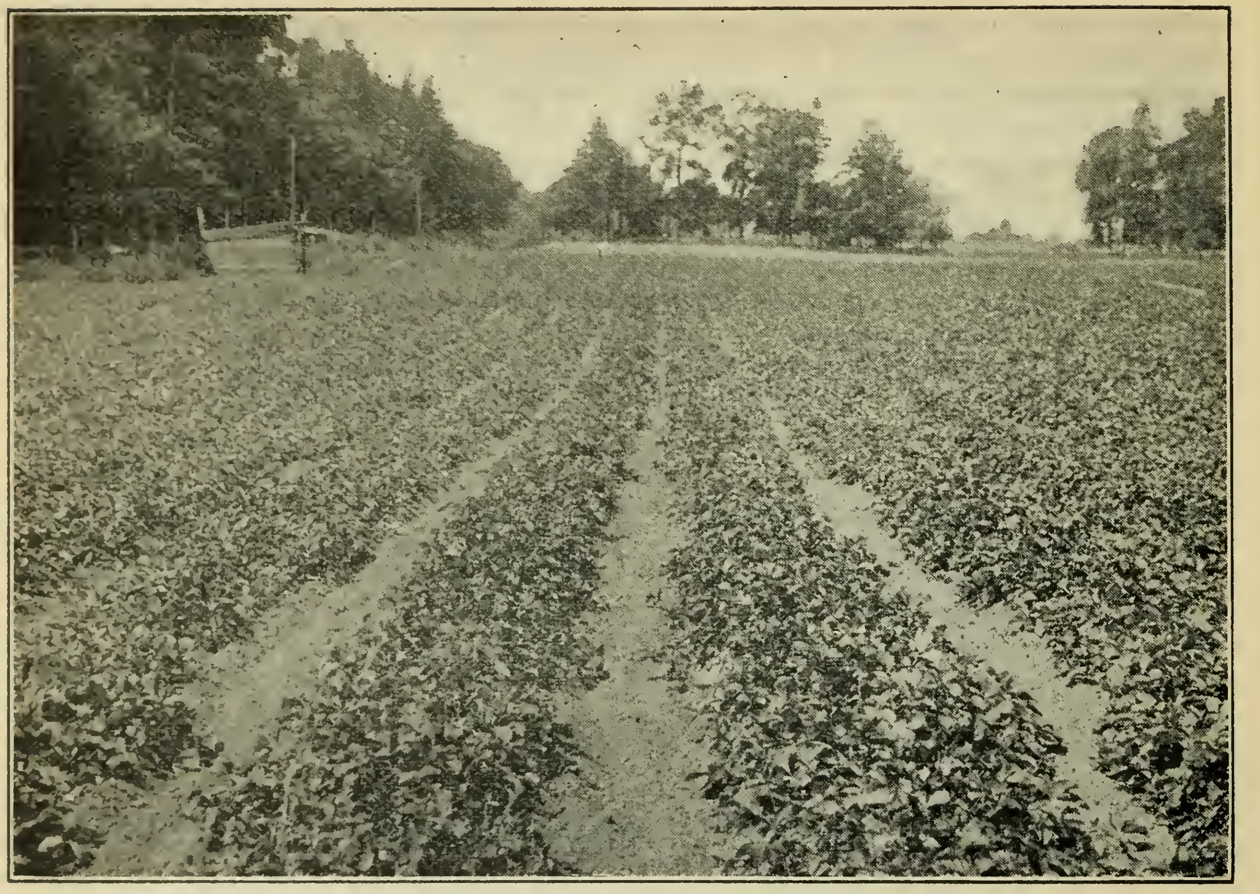
This heavy manuring is best done during the season preceding planting or when the hoe crop is being grown. Any manure that is applied when the field is being prepared for the strawberry plants in the spring should be well rotted, as strawy manure tends to loosen and dry up the soil especially if the season be unfavorable. Acid phospate or bone meal may be added with the final cultivation before planting. The further use of commercial fertilizers is discussed later under the title "Care of the Young Plantation".

It is evident from the foregoing that a rich soil is recommended for the strawberry. Yet a crop of strawberries removes relatively little plant food from the soil as compared with most other crops, corn and wheat for example. The necessity for a rich soil for the strawberry however, lies chiefly in the fact that the period between the blossom and the ripe fruit is very short. The plants have about four weeks only in which to bring to maturity a crop that in weight may outweigh the plant itself three or four times. Hence the necessity for readily available plant food in large quantity, and, as previously intimated, ample moisture during the ripening period.

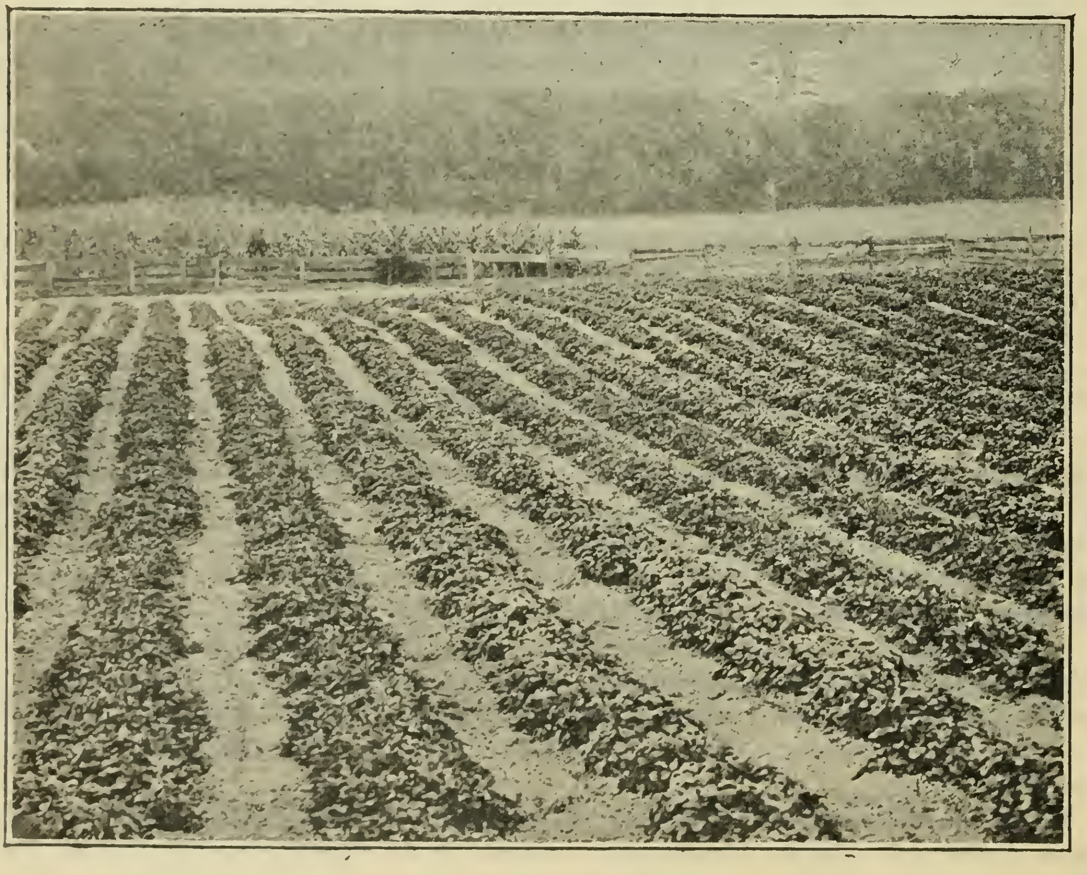
PLANTING

Systems of Planting. In Ontario the matted row system is followed in practically all commercial plantations. The "hedge row" systems are merely modification of the matted row. The hill system, which is in general use in British Columbia, is not adapted to Ontario conditions. Our winters are such that, due to heaving, there is too great a loss of plants in the hill system, and a consequent reduction in yield. Also it is doubtful if, even if climatic conditions were favorable, our present varieties would thrive in the hill system. In experiments at this Station with the hill system there was some evidence that the variety used, Williams, would not develop the large size plants necessary to successful hill culture. Individual plants in adjoining matted rows, were more vigorous and better developed than in the hill system where runners were removed and the original plant only permitted to remain.

In the questionnaire the enquiry as to width of matted row preferred brought forth a variety of replies. Preferences seemed to be about equally divided between narrow, medium and wide rows, the proponents of each giving excellent reasons for



Matted row of medium width.



Narrow matted row.

their choice. Width of row would seem to be partly a question of personal preference, and partly a question of site and soil, individual growers adapting their method to their particular conditions. A number of growers report that the narrow matted row will not hold moisture as well during a dry season as will a row of greater width. One grower reports the reverse to the above.

In general it may be said that, providing the individual plants have sufficient room, the medium to wide rows will give a greater yield of fruit than will the narrow rows. On the other hand, if the rows are too wide there will be some loss of fruit through crushing by pickers. Also if the plants are not sufficiently well spaced, the centre of the row will be relatively low in yield, the best and most fruit being borne on the edges. A row of medium width with well spaced plants should be the ideal sought for under average conditions. From the standpoint of yield per acre rows of moderate width planted 3 to 3½ feet apart will give a greater yield than wider rows planted farther apart.

Wide matted row before picking time.

Distance of Planting. This will vary to some extent with the variety and with the locality and soil type. Most growers prefer three and one-half to four feet apart for the rows with the plants 18-24 inches in the row. The Premier may be planted even closer than 18 inches on some soils, as it is often a somewhat indifferent plant maker.

A desirable practice followed by some growers is to space the rows 3 to 3½ feet apart with the plants 20 to 24 inches in the row. Previous to setting the plants the field is marked out both ways with the object of having the plants in sufficiently straight rows to permit of cross cultivation. Hand weeding and hoeing are thus reduced to a minimum. As the plants run freely, cross cultivation is narrowed down and finally discontinued.

Selection of Plants. Plant only the best. Many growers are still making the mistake of setting plants from the edge of the row. In this way they unconsciously select the last runners that were formed the previous year, most of which, because of their lateness in forming, have not yet developed strong root systms. Such runners cannot be expected to make first-class parent plants. It is much to be preferred to dig up all the row, the best row in the patch, and select from this only the best plants, those with large, white, healthy roots. Do not set the old black rooted parent plant or any plant that has been weakened by disease, frost or water. The poorer plants can easily be distinguished by the dark and discolored roots. Plants from old beds should not be taken. Make the selection from beds which have not yet fruited.

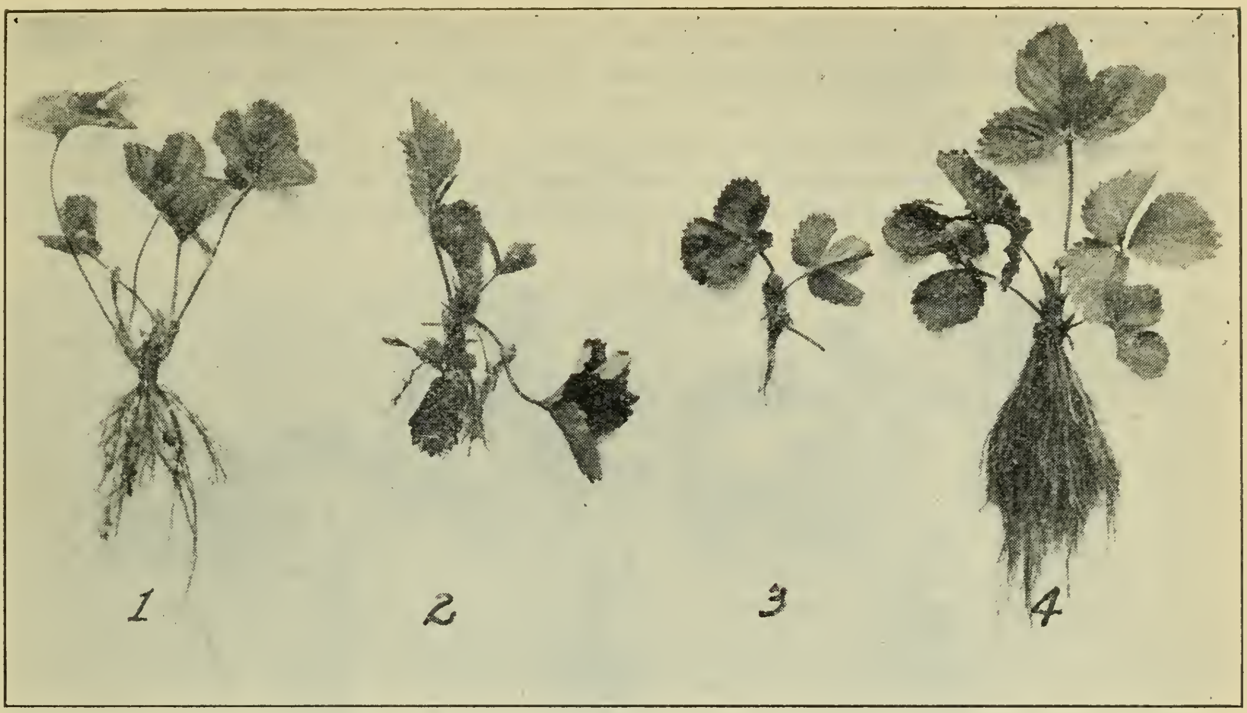
Time of Planting. Growers are practically unanimous in agreeing that planting should be done as early in the spring as soil conditions and the development of the young plants will permit. The strawberry is essentially a lover of moderate to cool temperatures. The early planting gets the plants off to a start which plantings of even a week or ten days later may never attain. This is particularly the case where the summer months, whether from heat or drought or both, are unfavorable to strawberry growth. Once well established, due to early planting, the young plantation will withstand unfavorable conditions much better than later plantings. Also the early planting under average conditions will give earlier formed runner plants and, as these runner plants will be better developed by fall than on later plantings, there will be in all probability a corresponding increase in yield.

Setting the Plants. The plants may be set in either spring or fall, spring however, being the recognized time for Ontario conditions. As soon as the plants have developed one or two sets of leaves they should be carefully dug with a fork, pruned (if such is the practice of the grower) and set at once. Wilting or drying out must be avoided. If the day is very drying cover them carefully with a sack or cloth as they are packed into the planting basket. Sometimes the plants develop too much top before the grower is ready to transplant, in which case it is well to remove all but two sets of leaves. The roots are usually shortened back about one-third of their growth thus avoiding any drying out incident to the extra handling.

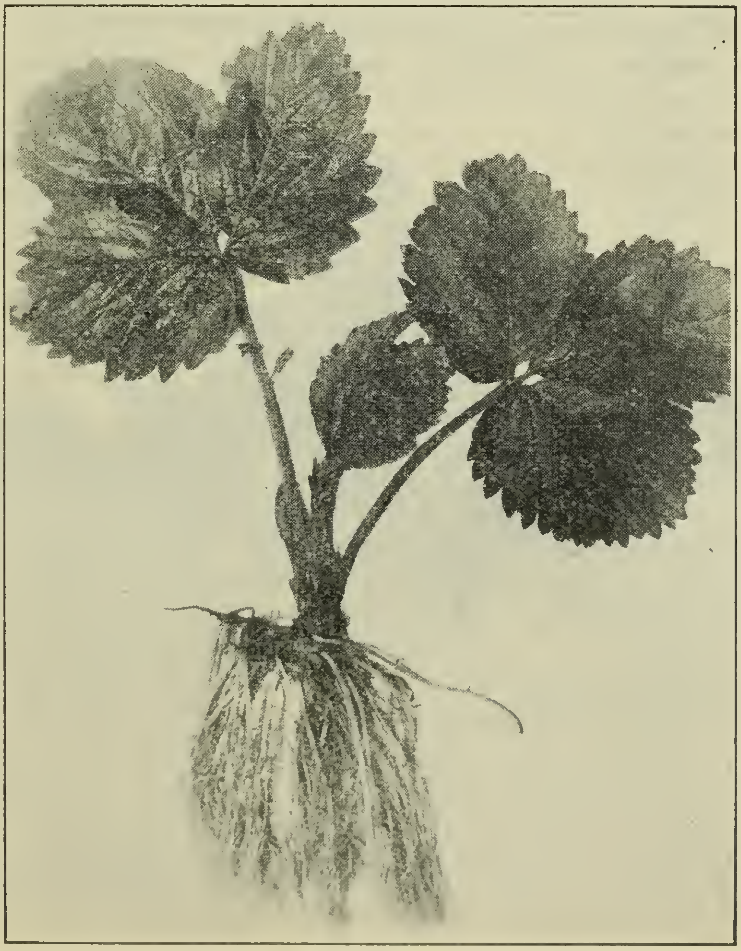
Usually two men or a man and a boy are employed in each gang to set the plants and they may use either a spade, trowel or dibble. The spade seems to be the most popular tool though the dibble is used a great deal. The man with the spade walks backward following the marks, and makes a three-cornered hole by pushing the spade into the ground with the left foot about three or four inches, shoving it slightly from him and then with his foot still holding one side of the spade pulling the top toward him. This makes a three-cornered hole, into which the boy places the plant, holding it firmly until the spade is removed. The foot is then used to pack the earth firmly around the plant. A plant is too loose if it can be pulled out by the strongest leaf stem. The boy is expected to place the plant at the proper depth and hold it in place until the soil is firmed. This method is much superior to working the spade backward and forward, as it does not pack the sides of the hole or leave an open space below the plant. Also with a little practice it is much quicker. Great care must be taken not to injure or cover the crown of the plant when tramping. Also care must be taken not to plant too deep or too shallow. The crown should be even with the surface of the ground. If too deep the crown may rot; if too shallow the roots dry out.

The dibble is used in a similar way. A surer way of securing a stand than either spade or dibble especially if the soil is dry and the weather unfavorable, is to use a trowel. The roots are then spread at a depth where there is moisture and covered carefully and firmly. This method though, is comparatively slow, and is not advised where conditions are at all favorable to growth.

Practically all growers use the spade method of planting in preference to planting in a furrow. They believe the latter method, because of the greater soil disturbance, tends to more drying out of the soil. They also believe that the furrow method is slower and therefore more expensive than the spade. On the other



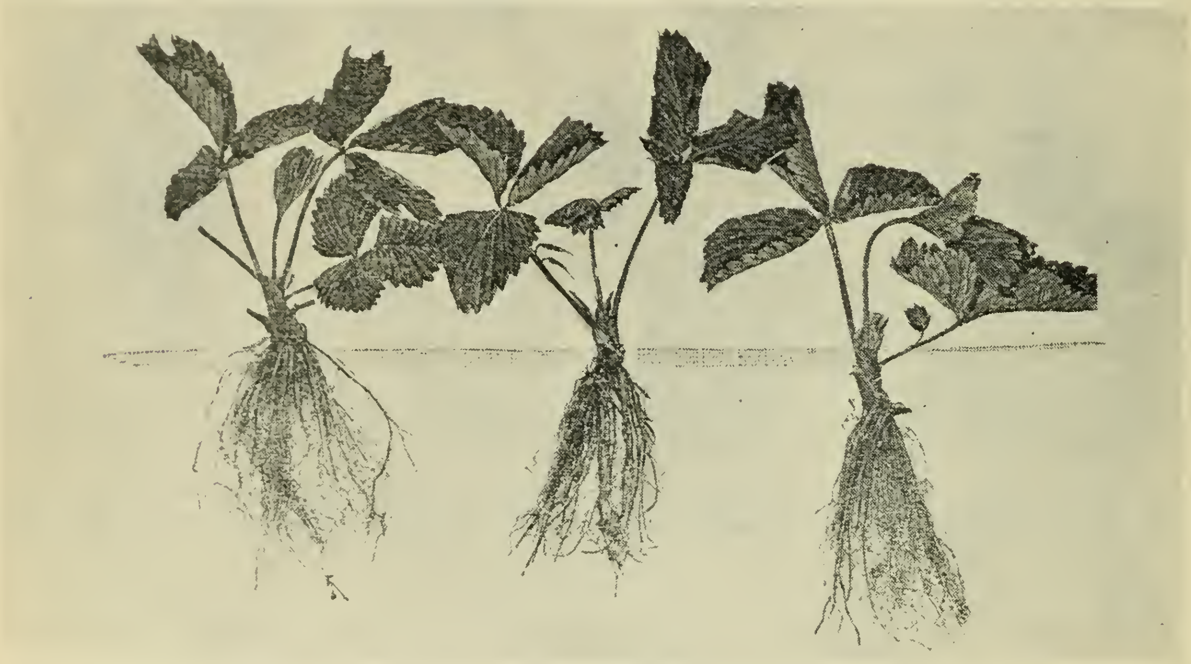
(1) Overdeveloped crown, and too small root; (2) both crown and root too small; (3) a very young and undesirable plant; (4) a properly developed plant for transplanting.



The type of plant to set, well developed, vigorous and with many white roots.

(*Courtesy of Dominion Dept. of Agriculture*) hand one grower who has been using the furrow method since 1919 states definitely that he finds it quicker and cheaper than the spade method, and less likely to dry out.

A number of growers who use the spade method in principle, prefer to use a round pointed implement such as a shovel, claiming that no air space is left as with a spade. One grower reports using a shortened tiling spade for the same reason.



Planted too shallow. Planted proper depth. Planted too deeply.

Planting machine in operation.

(*Courtesy of Prof. T. G. Bunting, Macdonald College*)

Planting machines are used by but few growers principally because the new acreage set each year is not sufficiently large to justify the expense of the machine. Growers who do use a machine generally find it satisfactory. The following paragraph, written by Prof. T. G. Bunting, of Macdonald College, and which appears in Bulletin No. 80 of the Dominion Department of Agriculture. "The Strawberry and its Cultivation in Canada", will be found of interest.

"A transplanting machine is indispensable on the larger acreages of strawberries. It greatly reduces the cost of planting, increases the speed and provides facilities for watering the plants as they are set in the rows if the soil is somewhat dry. It is operated by a man and team, with two boys, who, seated at the rear and at the sides, place the plants in the trench made by the machine. The depth of this trench and the amount of water applied may easily be regulated. This machine, with experienced labour, will set as many as 25,000 plants, three to four acres, per day at a cost of 40 to 50 cents per thousand. To this must be added some additional cost for the more careful preparation of the plants for machine planting as compared with hand-setting. The plants should be carefully prepared and be uniform in size, and have the roots well straightened out and all dead leaves and runners removed, so that the operators may handle them as rapidly as the machine moves. In loose or light soil the machine may not pack the soil firmly enough about the roots, and the operators may miss an occasional plant especially at the ends of the rows. In this case it is well to have an additional man follow the machine to tramp the soil about the plants, straighten misplaced ones and fill in any gaps that may occur. Careless planting may mean greatly decreased yields and low returns."

CARE OF THE YOUNG PLANTATION

Frequent and thorough cultivation is the important thing. It should begin when the plants are set and be continued throughout the summer and fall to keep down weeds and to maintain a mellow soil condition. Cultivation both ways until runner plants begin to form, is desirable, and can be given if the field was marked out both ways previous to setting.

Early cultivation may be comparatively deep, but as the season advances, it should become shallower and shallower so that the shallow rooting system of the newly formed plants may not be interfered with. The soil dries out to the depth of cultivation, and runners do not set well when too far from moisture. When cultivating it is good practice to always cultivate the same way on each row, so as to avoid disturbing plants previously trailed into position by the cultivator.

The cultivation should be supplemented with the hoe. A careful man with the hoe can do much towards increasing the crop. Every new plant formed by the runner should have a space of at least four or five inches square, and while it is not practicable to space the runners by hand the man with the hoe can do much to prevent crowding. If a runner is placed where wanted and a little earth placed on it, it will take root and grow. The first runners to start should be given particular care and encouragement, as it is the early formed runners that are most productive. The mistake is often made of conserving all runners, no matter how great in number they may be. This, of course, is advisable where they are not more than sufficient to make a good matted row. But if the new plants average, as previously stated, one to about four or five inches square, there is nothing lost, and usually much gained by cutting out the surplus. Also all surplus runners which extend beyond the required width of row should be removed.

In the new plantation the man with the hoe is also expected to pinch off all blossoms as they appear. This practice conserves for plant production all of the energies of the parent plant.

Fertilizers. The general fertilizing program for strawberries has already been discussed in the paragraphs entitled, "Soil Preparation and Fertilizing". A soil rich in plant food previous to setting the plants has been shown to be the desirable condition. Such a soil promotes early runner formation, and consequently gives increased yields. However yields may often be further increased by application of readily available nitrogen in September. Such applications tend to stimulate fruit bud formation, which is reflected in the crop the following season.

Also in soils which may be low in available nitrogen, spring applications of nitrogenous fertilizers such as Nitrate of Soda and Sulphate of Ammonia, may be beneficial in increasing the set of fruit and the size of the individual fruits. Such applications should not be heavy, perhaps 100 to 150 lbs. per acre, if applications have already been given the previous fall. Fall applications could safely be made at double the above amounts. Some injury to foliage may be caused by broadcasting Nitrate of Soda or Sulphate of Ammonia over the patch. This may be largely avoided by applying the fertilizer when the plants are quite dry, or by being careful to apply only between the rows. The latter method is safer for Sulphate of Ammonia. Application is also facilitated and danger from burning minimized by mixing the fertilizer with an equal quantity of dry earth, and then broadcasting.

It should be recognized that the foregoing recommendations,—if they may be termed such,—as to applications of commercial fertilizers, must necessarily be general at best. The profitable use of fertilizers depends on many factors including soil type, its native plant-food content, physical condition and previous treatment, age of the plantation, method of culture and the variety itself. The use of fertilizers is largely a local and personal problem, and one therefore which the grower must work out for his particular conditions.

WINTER PROTECTION AND MULCHING

If the soil is at all inclined to be wet or subject to standing water, furrows should be opened where necessary. Even on tiled land and land with an open subsoil this is good practice. Oftentimes during a thaw in winter water collects in low places and unless the furrows are opened, and sometimes even then, ice forms and destroys the plants.

Mulching. A good heavy row of plants is sometimes all the protection that is needed, especially in the parts of the Province where there is a fair snowfall and the winter temperature is fairly uniform. But snowfall and steady weather cannot always be depended upon and if the weather is unfavorable heaving of the plants on the heavier soils will result. A steady cold when the plants are at all protected is not so injurious as freezing and thawing. Strawberries, like wheat, will not stand this, unless there is a heavy top, and even then some plants are weakened. Generally it is best to supply the cover by mulching the rows with a light covering of farmyard manure or straw. This covering does not need to be heavy, but still of sufficient thickness, about two or three inches, to prevent drifting, and alternate freezing and thawing. The object of the mulch is not to keep the plants from freezing but to prevent them from being affected by frequent temperature changes. Snow, if sufficient and to be relied upon, will do this. The necessity for mulching increases as the permanence of the snow blanket lessens.

The mulch should be applied as soon in late fall or early winter as there is sufficient frost to hold the wagon nicely. No damage can be done at this time to the cultivated and consequently loose ground. Do not wait too long, as the mulch is better under the snow than on top of it.

Many growers do not make a practice of removing the mulch from the rows in the spring, but rather loosen it up well to permit the plants to work their way through. The mulch must be light in such cases if manure has been used. The better way is to rake between the rows all rough or coarse materials to act as a mulch there, where it will conserve moisture and tend to keep the fruit clean. This is best done about the time that here and there in the patch a few leaves begin to blanch from too much cover or protection. If it is desired to hasten the fruiting season, the mulch may be raked between the rows much earlier or as soon as there is any sign of life or growth. Most growers prefer however to leave the mulch undisturbed until danger of frost is over and weather conditions seem to be settled. Some growers remove the rough part of the mulch entirely from the field and cultivate until the picking season. Others take the material between the rows, and leave it there to act as a mulch, conserving moisture, etc., as already indicated. This latter method is the one usually preferred.

There is one serious objection to the mulch, and that is, unless the manure, or straw, is practically free from weeds such a number of seeds are scattered over the field that it is almost impossible to keep the patch free from them. This applies even more strongly when the patch is to be kept for a second or third crop. Because of this objection many of the best growers do not mulch at all, but rather manure heavily before the plants are set and depend on them to make sufficient growth to protect themselves. It seems safer, though, as a rule, to mulch with as clean manure or straw as can be obtained, and chance damage from weeds rather than damage from freezing.

The choice of material to use for mulching is determined largely by local conditions. In the Simcoe-Waterford district straw, and preferably rye straw because of its greater freedom from weed seeds, is used almost exclusively. As compared with manure, straw is relatively cheap there, it is freer from weed seeds than the average manure, it keeps the fruit cleaner during the picking season, and on the light Norfolk soils it is probably more retentive of moisture than manure.

Strawy manure is preferred in the other commercial strawberry areas for various reasons. Land is higher priced requiring more intensive agricultural methods and also straw costs much more than it does in Norfolk county. Also manure is relatively easy to secure while straw is not and this has tended to establish the habit of using manure without reference to actual merit. It may be suggested however that clean rye or wheat straw should be tried more extensively in the Niagara, Burlington and Clarkson districts, particularly by growers who desire to carry their plantations over for a second crop.

In reply to a query concerning mulching materials the following information was received from Capt. L. B. Reynolds of Waterford,— "I have always been taught that rye straw, on account of its cleanness, freedom from weed seeds, and its length and toughness was the very acme of perfection for covering strawberries. It lays lightly and does not pack so as to smother as oat or buckwheat straw does. Neither does wheat straw, but as it is harvested later than rye, it is far more likely to contain weed seeds, especially thistles . . . . I have used manure twice to finish up a piece, on running short of straw, and each time considered the pieces so covered too weedy after picking to keep over for another season."

RENEWING THE PLANTATION

The practice of renewing, or of taking a second crop from the plantation, is favored by most growers. They are all agreed however that it does not pay to renew unless the patch is in good condition and reasonably free of weeds at the end of the first picking season. If the plantation meets these desirable conditions then renewal is certainly advisable as production costs for the second crop are considerably less than for the first crop. The yield may be somewhat less than on a new bed, but this will likely be offset by earlier ripening and consequent higher prices on the old bed. Insects and diseases are of course likely to be more troublesome on old beds carried over than on new beds.

Renovation may be accomplished in various ways and according to the individual tastes of different growers. In Norfolk county the practice of mowing the patch and then when dry, burning it over is quite common. In other districts mowing the tops is not commonly practiced. In all sections, following the fruiting season, the general practice is to narrow the rows down, usually by plowing off one side of each row. This is then followed by frequent cultivation which may be in one direction only—with the rows—or which may be supplemented with a thorough harrowing both ways, i. e., with and across the rows. If cross harrowing is practiced, the soil should first be well worked between the rows. Cross harrowing may safely be done on patches which have been mowed, but it is doubtful if it will be found satisfactory under other circumstances.

Following the narrowing and initial cultivation, the hoe should be used vigorously to clean out all weeds and to considerably reduce the number of strawberry plants which are to be allowed to remain. Cross-harrowing, if practiced, will already have thinned the plants considerably. A few strong healthy plants will make a good row by fall. At the same time it is not well to thin too much. Some have recommended to leave the plants as much as sixteen inches apart, but if the season be unfavorable for plant development this involves a great deal of risk; better to leave the plants fairly close, and if too many runners are produced cut some out in the fall.

Renewing the old plantation. The first step—narrowing the old row by ploughing off the side.

(*Courtesy of Dominion Dept. of Agriculture*)

PICKING

The picking and marketing of the fruit is the biggest problem that the grower has to face. Where only small areas are grown the necessary assistance can usually be obtained from the neighboring families or nearby villages, but when many acres are grown other provision for handling must be made early in the season. The pickers must be ready when the fruit is. Generally on the best managed fruit farms there is work for a number of people from early spring till late fall. The strawberry plants must be set, tomatoes transplanted, weeds, etc., kept under control; and again, when the strawberry season is over, there is the old patch to renovate, and raspberries, currants and other fruits to pick, etc. In many cases the grower engages one, two, three or more families of Indians and houses them in fairly comfortable shacks. These people, with a little experience, make very good workmen; but they must be kept busy, and consequently, if picking and general farm work is spread out well over the season, the problem of assistance is solved for a time at least.

Italians and Poles are used similarly, and make very good workmen indeed, but are not so easily handled as a class. The women and girls make the best pickers, and when properly directed have helped many a grower out of a serious difficulty.

The berries are ready to pick when they are from three-fourths to all red in color. They should not be allowed to get over-ripe, which does not take long, especially if the weather is hot and dry. If over-ripe and dry they sour, and if over-ripe and damp they mould. There still seems to be a feeling among many growers that "strawberries are strawberries," and that there is no place for grading according to size, quality, etc. But such is not the case. Medium to large berries of good color and not over-ripe always bring a higher price than fruit of all sizes, especially if it is shrivelled and "mussy" looking. Small, green berries here and there in the box, and some that are decaying from being left too long on the vines, always detract from the appearance. It is a safe rule to remember that someone is expected to eat every berry put in the box, and that previous to eating someone is expected to make them look attractice, and, lastly, that a good berry increases demand, while a poor berry decreases it. Firm, attractive berries carefully packed so that the skin remains unbroken, and properly graded will bring repeat orders.

Why not take as much pride—a few are already doing so—in the picking, grading, packing and marketing of the strawberry as in the apple, pear or peach? It is a smaller fruit, and very perishable, but when marketed attractively, is in great demand.

YIELDS AND RETURNS

We are many times asked concerning yields, as the prospective grower has heard of some almost fabulous quantity being produced on an acre. But the average grower does not get anything like the number of boxes per acre that is sometimes reported. Instances are known of where patches of one acre or more have yielded, under the best conditions, but no irrigation, over 13,000 quarts per acre. Such patches, however, are comparatively rare. About 5,000 to 7,000 quarts per acre is a good yield and considerably above the average. Census figures show that the average yield is approximately 1,700 quarts per acre. This average includes good, bad and indifferent growers of course, and is therefore far below the yield that a good grower may reasonably expect.

As to prices, in the questionnaire sent out to representative growers, the question was asked "With satisfactory yields what price per quart is necessary to insure a fair profit?" The answers were many and varied, ranging from a modest 8c (canning factory price, returnable crates, etc.) to 18c, the latter being the price expected from the generous summer vacationist along the St. Lawrence. All replies averaged gave a minimum desirable price of 11c. Replies received from the Simcoe-Waterford area averaged 12c; from Burlington and Clarkson 12c; and from the Niagara District 9½c.

Returns per acre are dependent on so many factors apart from price fluctuations due to seasonal conditions, that there seems little object in including such estimates in this bulletin. Price of land is the major determining factor in net returns; also availability of labor, and yield particularly. On the higher priced lands as in the Clarkson district, high yield is absolutely essential to profitable production.

CULTURE OF EVERBEARING VARIETIES

Though not yet commercially grown in Ontario to any appreciable extent, the so-called everbearing or fall-bearing varieties of strawberries are beginning to attract considerable attention. A number of growers, well situated as to market, are finding the fall crop, while not large, to be quite profitable.

While these varieties have a tendency to bloom continuously from early summer until late fall, yet the bulk of the fruit is borne in two fairly definite periods,—in June as with ordinary varieties and again in the fall. Neither crop will be as large as the yield from a good June bearing variety. However if the demand for the fall crop is sufficiently good this will not matter greatly. Removal of the June blossoms so as to conserve energy for the fall crop is sometimes advocated.

Everbearing varieties are, as a whole, poor runner makers, the plant's energies being directed to fruit production rather than runner production during the late summer and fall. Varieties may eventually be originated which will not have this weakness. Rockhill, a new everbearer, but not yet generally distributed, is said to be a good runner maker. Other good everbearing varieties are Duluth, Forward and Mastodon.

Promising new varieties originated at the Central Experimental Farm, Ottawa, but not yet introduced are reported in their Bulletin No. 80. With reference to the cultural treatment of everbearers, the following paragraphs are quoted from Dominion Department of Agriculture Bulletin No. 80 New Series.

"Sometimes it is expected that the everbearers will produce a full crop in June and follow with another crop in the fall. Our experience indicates that better results are obtained by taking a crop in the fall of the planting year, and a June crop in the following season. With this in view and considering that these do not make as many runners as the June sorts, the planting scheme is modified somewhat.

In the first place if planted in the early fall or late autumn there are not only earlier rooted stolons but more plants for the first fall crop; and secondly if planted closer together than is ordinarily recommended for June sorts, much greater returns per acre are secured. Planting in double rows 3 feet apart from centre to centre is sufficiently far apart. The two rows constituting the double rows may be 1 foot apart with the plants 1 foot apart in each row, but placed so that they are alternate instead of opposite. This is close planting, but sufficiently far apart for any varieties we have tested that are worth growing.

As the fall bearer is forming fruit-buds during early summer or shortly after rooting for the fall crop, it is imperative for best results to have an available supply of plant food, especially nitrogen. An application of nitrate of soda made in June in soils not overstocked with nitrogen will give good results in this respect."

IRRIGATION OF STRAWBERRIES

Undoubtedly the largest single factor affecting yield is that of moisture supply preceding and during the picking season. Richness of soil is of little value if moisture be not present in sufficient amount, as many growers will testify. In recent years prolonged dry spells at the critical period seem to have been unnecessarily frequent, so much so in fact that a number of growers have made provision for irrigation.

The usual method of irrigation is the overhead or so-called "Skinner" system, familiar to all so that no description of it need be given here. Where practiced, irrigation is giving excellent results as it gives the grower complete control over the moisture problem. The value of irrigation is most apparent of course in seasons of extreme and prolonged heat and drouth. Nevertheless there are few if any seasons in which irrigation would not materially increase the yield. Even two or three hot days at the height of the picking season play havoc with the plants and shorten the crop considerably.

There is some danger in applying water too freely as there is then a tendency to the production of soft fruit with consequent poorer shipping quality. Too much water may be as harmful as too little. The grower who irrigates should aim to give the plants sufficient for their needs only, and not attempt to force a large crop of soft fruit by excessive irrigation.

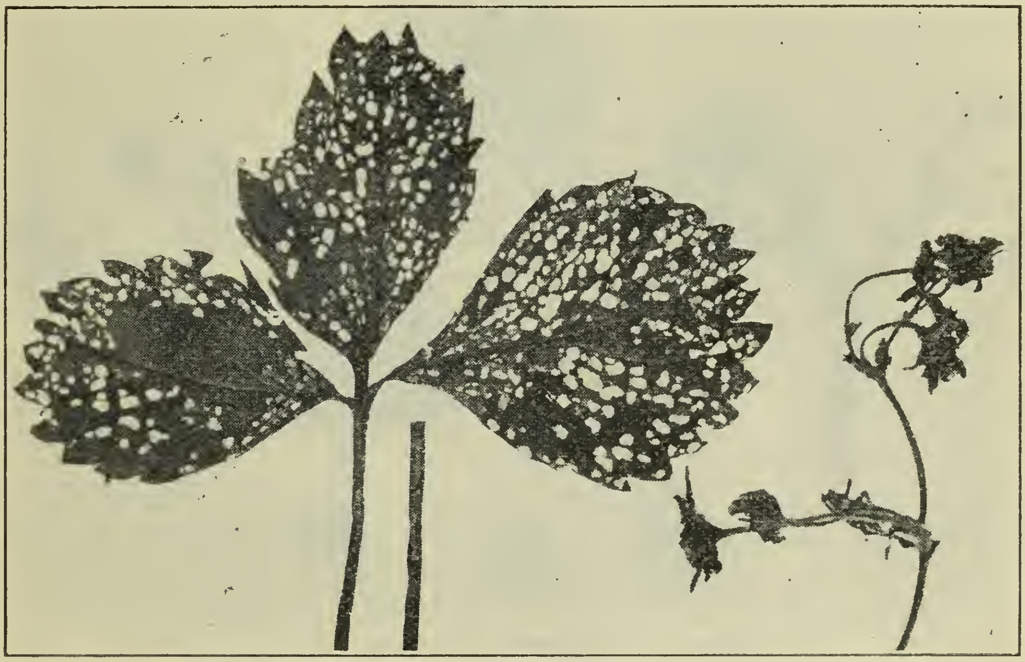
INSECTS AFFECTING THE STRAWBERRY*

The strawberry is attacked by several insects notably the Strawberry Weevil, The Strawberry Leaf Beetle, The Strawberry Leaf Roller, Cutworms and White Grubs. The detection of the particular insect responsible for observed trouble will be facilitated by the following,—

(1) The blossom buds are found to be wilting and dropping off before opening. The flower petals of the early spring blossoms may have one or two "shot-holes" in them. *See under Strawberry Weevil.*

(2) The leaves are pierced by numerous "shot-holes" especially in spring. *See under Strawberry Leaf Beetle.*

(3) The leaves are folded over, often across the midrib, and if opened up are seen to be fastened at their edges by a "spider-web-like" material. Small active caterpillars will often be found in such leaves. *See under Strawberry Leaf Roller.*



Work of Strawberry Leaf Beetle.
(*Courtesy of W. A. Ross*)

(4) The whole plant wilts down "overnight" and dries up. The plant is found to be cut off at or just below the ground level. Examination of the soil around the affected plant may reveal a dull-coloured, often coiled-up, caterpillar about an inch long. *See under Cutworms.*

(5) Plants are unthrifty, make poor growth and often gradually wilt down. Examination of the roots shows that the fine fibres are lacking and the root consists mainly of large roots. *See under White Grubs.*

THE STRAWBERRY WEEVIL *(Anthonomus signatus* Say.*)*

Occasionally strawberry yields are seriously reduced by the strawberry weevil—a small raddish-brown or blackish snout beetle about 1/10 inch long, which cuts off the blossom buds. Early varieties of strawberries apparently are most subject to serious injury. Varieties with imperfect or pistillate flowers are practically immune. On hot still days the weevils are most active and can then be readily seen working on the buds.

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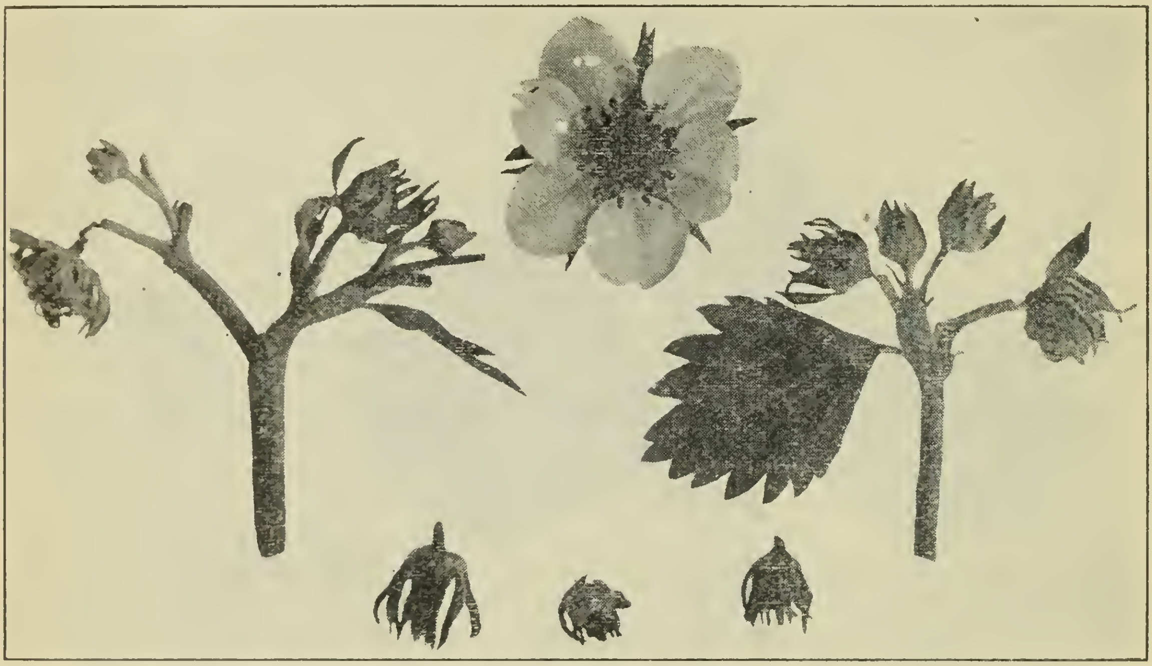
*This section has been compiled almost entirely from information prepared by the Dominion Entomological Branch for Bulletin No. 80 of the Dominion Department of Agriculture. In most cases paragraphs have been taken complete, without change.

Control.—(1) Clean Farming: As the adult weevils hibernate over winter under rubbish, particularly in woodlots and waste land adjoining the strawberry fields, it is important to secure as clean conditions as possible in and around the strawberry plantation. This involves the destruction of weeds, rubbish and anything which may afford the weevil winter protection. It is also advisable not to plant strawberries near bush or waste land.

(2) Dusting: Almost complete protection from the weevil may be obtained by coating the plants with a dust composed of sulphur and arensate of lead, either a 90-10 or 85-15 mixture. Ordinarily two applications are sufficient, the first when weevil feeding begins, and the second immediately after a washing rain, or seven days later than the first application, if the weather is dry. It is essential that all the buds be kept coated with the dust until they open. The only satisfactory way of applying the dust is with a power duster or a good make of hand-blower.



Work of Strawberry Weevil.
(*Courtesy of W. A. Ross*)

THE STRAWBERRY LEAF BEETLE *(Paria canella* Fab.*)*

In Eastern Canada strawberries are occasionally injured by a dark brown or black, shiny, oval-shaped beetle about 1/8 inch long—the Strawberry Leaf Beetle. The leaves will be found riddled with "shot-holes" giving a lacework effect. In addition to the strawberry this insect may attack raspberry, blackberry, apple and some other plants. The larvae feed on the tiny rootlets of the strawberry plant thus further weakening it.

Control.—As soon as the beetles are found feeding on the leaves, spray thoroughly with arsenate of lead (dry) 2 pounds, or calcium arsenate (dry) 1½ pounds, in 40 gallons of a 4-4-40 Bordeaux mixture.

THE STRAWBERRY LEAF ROLLER *(Ancylis comptana* Frohl.*)*

This insect has not proved very troublesome in Canada although occasionally it has effected important injury. The caterpillars fold the leaves and fasten their edges with fine silken threads; they feed upon the surface of the leaves within the shelter thus formed. The adult are small inconspicuous moths, seldom noticed except when present in large numbers.

Control.—If the presence of this insect is not detected until the leaves are folded, as is usually the case, the caterpillars are so well protected from spray materials that nothing can be done until the crop is harvested. As soon as the crop is off, run the mower over the rows and immediately rake the leaves between the rows and burn them. Next spring spray the plants just before the blossoms open with arsenate of lead (dry) 2 pounds, or calcium arsenate (dry) 1½ pounds, in 40 gallons of 4-4-40 Bordeaux mixture. Where the old plantation is not to be saved for another year, it is best to plough it under as soon as the crop is off in order to prevent the insects from infesting the new plantation.

The new plantation can be kept free by removing and crushing folded leaves at time of planting and by keeping the leaves coated with spray until the old plantation has been ploughed down or mowed off and the leaves burnt. Spray as soon as the plants are set out with the same mixture advised for the old plantation, and repeat when the coating becomes removed by heavy rain or when new unprotected growth appears. Protection by spray must be given until neighbouring sources of infestation have been removed or treated.

CUTWORMS

Several of the well known cutworms may in any season cause much injury to young strawberry plants. Injury by cutworms usually ceases before the end of June. When they are present in numbers in a garden or field the plants will soon be seen to have been cut or eaten off, and if an examination is made, the cutworms will most likely be discovered in the soil coiled up and just below the surface.

Control.—The poisoned-bran remedy is the one which is now used most extensively for the destruction of cutworms generally. This is made as follows:

Bran	20 pounds
Molasses	1 quart
Paris green or white arsenic	½ pound
Water	2 or 2½ gals.

Mix the bran and Paris green (or white arsenic) thoroughly in a wash-tub, while dry. Dissolve the molasses in the water and wet the bran and poison with the same, stirring well so as to dampen the bran thoroughly.

The mixture should be applied thinly as soon as cutworm injury is noticed. It is important too, that the mixture be scattered after sun-down, so that it will be in the very best condition when the cutworms come out to feed at night. This material is very attractive to them, and when they crawl about in search of food, they will eat it in preference to the growing vegetation. If the mixture is put out during a warm day, it soon becomes dry, and is not, of course, so attractive to the cutworms.

WHITE GRUBS *(Lachnosterna spp.)*

White grubs are the larvae of May Beetles or June Bugs and are well known to most growers. By feeding on the roots the larvae either kill or seriously weaken the strawberry plants. They are usually most troublesome where strawberries are planted after sod. The grubs live in the soil from two to three years before changing into adults. In the second season particularly they feed heavily and do most damage.

Control.--Preventive measures consist in avoiding land known to be infested with white grubs, and in growing for one or two years, prior to planting strawberries, such crops as beans, peas, buckwheat or pure stands of clover, all of which are more or less distasteful to the grubs. In breaking up old sod land allow chickens or hogs or both free access to the field: they will destroy many grubs. It is unwise to attempt planting strawberries right after sod where white grubs are found. If the plants are set in soil free from white grubs and the plantation kept free from weeds, there will be little to fear from white grubs.

Where the grubs are discovered in the plantation after it has been set out, nothing can be done to destroy them.

STRAWBERRY DISEASES

The chief diseases of the strawberry are Leaf Spot, Powdery Mildew and Black Root. Gray mold of the fruit is sometimes troublesome also, and an apparent "mosaic" disease is becoming noticeable. This latter disease usually occurs in patches throughout the plantation, the yellowish foliage and stunted growth being conspicuous. In securing plants for setting new plantations these diseased patches should be carefully avoided.

Leaf Spot *(Mycosphaerella fragariae)*

This is the most common and most conspicuous disease attacking the strawberry. Fortunately it is seldom very serious except on old plantations. The disease occurs as irregularly distributed spots on the leaves. These spots are reddish or purplish at first, but later, as they enlarge, the centre becomes ashy white, bordered with red or purple. In severe attacks the loss in yield will be very heavy. There is another strawberry leaf disease called Leaf Scorch, but, so far as the practical grower is concerned the two troubles may be considered as one, as the same remedial measures apply to both.

Control.—Plants with healthy foliage only should be set out. Diseased leaves should be removed. Crop the plantation for two seasons only, then plow down. This will ordinarily give commercial control. In some cases however spraying may have to be resorted to, using Bordeaux mixture 4-4-40. Apply as soon as growth is well started in the spring, and make two or more later applications so as to keep the foliage well covered with spray. If Leaf Spot is serious late in the season. infection the following season may be averted to some extent by mowing off the leaves and burning over the plantation.

Powdery Mildew *(Sphaerotheca Humili* (Fries) Burr*)*

This disease has been quite common at times in some parts of the Province. In 1919 and 1920 it caused considerable loss and again in 1923 and later it was quite troublesome. Leaves of affected plants curl upwards as though from dry weather. exposing the under side of the leaves on which will be found the characteristic white powdery mycelium of the fungous. In severe attacks the leaves become dry, the plant may be completely destroyed. and the crop dry up and become useless.

Control.—Where the outbreak seems likely to be of sufficient severity to warrant it, control may be had by dusting with sulphur or with 85-15 lime-copper dust. Three or four applications may be necessary, depending on weather conditions. The initial application should be made when the disease first makes its appearance, with subsequent dustings at 10-12 day intervals.

Black Root of Strawberry

This plant condition has often been noticed in strawberry plantations. From 1902 to 1908 particularly it was reported serious in the States of New York, Michigan and Massachusetts. In Ontario also Black Root has often been widespread, causing severe injury in recent years. When the berries are about half grown the plants wilt and turn yellow. Usually the injury is confined to patches throughout the field. The roots of affected plants will be found to be black throughout instead of showing the characteristically white healthy core.

Control.—While *Fusarium* organisms have been shown to be present in diseased material. it is generally regarded that they are not primarily responsible for the disease, but rather that the black rooted condition is due to some form of winter injury. Improper cultural methods, lack of fertility, poor soil conditions, insufficient mulching are all contributing factors, and should be corrected. In addition only vigorous, white-rooted plants should be set.

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BULLETIN 336 **MAY, 1928**

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Cheese and Butter Making

By the Staff of the Dairy School

INTRODUCTION

H. H. DEAN, Professor of Dairying

This bulletin has an interesting history. It was originally prepared by Committees of the first Dairy School, held at the Ontario Agricultural College, in 1893. It has since then been revised from time to time by the Dairy School Staff. The present revision was made by the Staff of 1928. Thus, for thirty-five years there has been continuity of matter contained in this bulletin.

During this time many changes have occurred in the Dairy Industry of Ontario, chief of which are—the falling off in the exports of cheese and butter, and the importation of large quantities of butter, and some cheese, to supply our home trade, particularly during the winter months, when milk production in Ontario is comparatively small. If the Ontario milk-producer were assured a paying price for it, he would produce all the milk and milk products required to supply home markets, and have some surplus for export in the form of milk and cream, which is becoming quite an important trade along the United States border Counties of the Province.

The marvellous growth of towns and cities in recent years, and the development of condensed and powder milk plants, have caused an increased demand for milk and cream for direct consumption at prices which are considerably higher than are usually paid to patrons of creameries and cheeseries. The prices of butter and cheese must advance and the cost of manufacturing must be reduced in order that manufacturers of these two dairy products may be able to secure sufficient raw material to make the business profitable. This, in all probability, means larger establishments for manufacturing, which are equipped with better men and more modern machinery than is found in the average small factory for manufacturing dairy goods.

The grading of cream has been a marked step in advance and has already caused improvement in the quality of Ontario butter. The grading of milk for cheesemaking will likely follow.

Payment for milk and cream used in cheese and butter manufacture, according to the fat content, or, the option at the Cheese Factory of the "fat plus two" plan, is now compulsory in the Province of Ontario.

The following table is based on tests carried out by the Dairy Department of the College.

Average per cent. Fat in Milk	Pounds Cheese made per 1000 lbs. Milk	Pounds Milk required per pound of Cheese	Increased Yield of Cheese per 1000 lbs. Milk	Pounds Cheese per Pound Fat in Milk
3.0	88.9	11.2	....	2.92
3.5	95.4	10.5	6.5	2.70
4.0	103.6	9.6	8.2	2.57
4.5	110.8	9.0	7.2	2.47
5.0	117.7	8.5	6.9	2.36

When milk or cream is paid for on the basis of fat only, the pounds of milk or cream in the can are determined by weighing, and these are multiplied by the test or percentage of fat, and divded by 100, and this by the price per pound of fat. For example—a can contains 80 lbs. Cream, testing 30 per cent. fat, $80 \times 30 \div 100 = 24$ lbs. fat. 24×40 (value in cents of 1 lb. fat) $=\$9.60$, which is the value in dollars and cents of the can of cream. In the case of milk, a Patron who delivers 5000 lbs. of milk to a Cheese Factory testing 3.5 per cent. fat, would be credited with $5000 \times 3.5 \div 100 = 175$ lbs. fat, which, at 40c per pound fat are worth 175×40c, \$70.00. If payment be made on the basis of "fat plus two", proceed as follows: $3.5 + 2 = 5.5$; $5000 \times 5.5 \div 100 = 275$ lbs. fat-casein, which at 25.454 cents per pound, are worth, $275 \times 25.454 = \$70.00$.

TESTING MILK, CREAM, CHEESE AND BUTTER.

W. H. Sproule and A. P. Clark.

The commercial value of milk, whether used for direct consumption or for manufacturing into the various dairy products, is largely dependent on its chemical composition. If the milk be used for buttermaking, the fat will be the index of its value, for it is the fat alone which is used in the manufacture of butter. Since normal milk varies widely in composition it is necessary to determine the relative amounts of the more important constituents in order to know its market value. A chemical analysis will give the most accurate data, by which the value of milk may be estimated, but this method is too slow, and too expensive for use in commercial work.

The Babcock method of ascertaining the fat content in milk has solved the problem of a rapid, accurate, reliable and inexpensive method for testing milk and milk products for fat. It was invented by Dr. S. M. Babcock, of the Wisconsin Agricultural Experimental Station, and was first made public in 1890. Since then, it has been the almost universal milk-fat test in America. While the test is simple to operate, great care and accuracy must be exercised in all details of the work.

The cost of a small four bottle hand machine, such as is used on many farms, is \$10.00 to \$12.00. The price increases according to the capacity of the machine.

The accuracy of the test bottles and pipettes used in Canada is provided for in an Act of the Dominion Parliament known as the Milk Test Act, which requires that all bottles and pipettes shall be tested for accuracy of graduation by the Standards Branch, Department of Inland Revenue, Ottawa. Glassware when verified and found to be correct within a specified limit of error, must be ineffaceably marked with the outline of a crown having within it the initials of the reigning Sovereign.

Sulphuric acid weighs about 18 lbs. to the gallon, and costs 4 to 10 cents per lb. A gallon will make 250 to 260 tests.

In the testing of milk and its products it is necessary that the sample taken for testing represents the average quality of the milk, or milk products to be tested. **Otherwise the result cannot be correct.** To secure a representative sample of the fluid products it is best to pour the entire quantity from one vessel to another several times. If the quantity is too great to permit of pouring, it should be **well stirred.** After being thoroughly mixed a small quantity should be taken and put into a suitable vessel properly labelled or numbered and provided with a tight fitting stopper.

DETAILS OF THE BABCOCK TEST

The various details necessary to consider in making a Babcock Test of a sample of milk are given systematically as follows:—

1. Have the milk at a temperature of 60 to 70 degrees F.

2. Mix the milk thoroughly by pouring it from one vessel to another several times, allowing it to run down the side of the vessel to prevent foaming.

3. With a 17.6 c.c. (cubic centimeters) pipette, measure this quantity of milk and deliver into a milk test bottle. To do this draw the milk into the pipette, and quickly place the fore finger over the top to prevent the milk running out. Allow the milk to drop out until the surface is level with the 17.6 c.c. mark, which is on the stem above the bulb. Now place the tip of the pipette into the top of the bottle and allow the milk to run out slowly by removing the fore finger.

4. Using a 17.5 c.c. acid measure, dipper or burette graduated to 17.5 c.c., add to the milk in the bottle 17.5 c.c. of commercial sulphuric acid, having a specific gravity of 1.82 to 1.83, and a temperature of 60 to 70 degrees F. Hold the bottle in a slanting position allowing the acid to run down the side and under the milk; also, revolve the bottle slowly so that the acid will carry all the milk down out of the neck.

5. Mix the milk and acid thoroughly by giving a gentle rotary motion. Do not close the neck of the bottle while mixing.

6. Place the bottles in the machine so that they are properly balanced, and whirl at the speed indicated on the machine for five minutes.

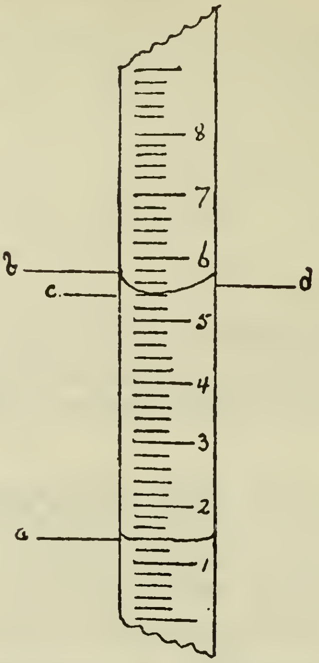
7. Add hot, soft water at a temperature of 160 to 170 degrees F. to the base of the neck, and whirl for two minutes at the proper speed.

8. Fill to the 7 or 8% mark with soft water at 160 to 170 degrees F. and whirl one minute at the same speed.

9. Remove the bottles from the tester and set in a water bath, which reaches to the top of the fat, at a temperature of 140 degrees F. for at least 3 minutes before reading.

10. Read with the use of a pair of dividers by measuring from the base of the fat column to the top of the meniscus, and then by placing one point of the dividers at the zero mark the other will indicate the percentage of fat in the milk. The accompanying illustration will

show the correct method of measuring the fat column of milk tests. The correct measurement is from A to B **not** to C or D.



11. Empty the bottle while hot, shaking to assist in carrying off the sediment at the bottom, rinse with hot water, then wash with hot water and washing soda using a brush. Again rinse with clean hot water. If burnt on curd has accumulated use shot or a small amount of water and sulphuric acid in equal quantities, then proceed as above.

Abnormal Appearance of the Fat Column.—When the test is made properly and in accordance with the foregoing directions, the fat column is perfectly clear, of a golden yellow color and the top and bottom curves are sharply defined. Burned readings or the presence of charred and dark curdy masses in or under the fat column may be caused by:

(a) Too high a temperature of the milk or acid.
(b) The use of too strong or too much acid.
(c) Allowing the acid to drop directly on and through the milk.
(d) Allowing the milk and acid to stand too long before mixing.
(e) Interrupting the mixing of the milk and acid after beginning and before completing.
(f) Shaking the bottle too vigorously.

Light or cloudy readings or floating particles of curd are usually caused by:

(a) Low temperature of milk or acid.
(b) Weak or insufficient acid.
(c) Careless or insufficient mixing.

The appearance of foam on the surface of the fat column is caused by the use of hard water. When soft, distilled or clear rain water is not available, the water may be softened by the addition of a few drops of sulphuric acid before heating; or, by boiling the water before using.

Such tests as the above should be rejected as the readings of the same are prone to be inaccurate.

Theory of the Babcock Test.—A 17. 6 c.c. pipette will deliver practically 17.5 c.c. of milk. 17.5 c.c. at an average specific gravity of 1.032 (17.5 × 1.032) = 18.06 grams.

18 grams is the weight of the milk required for a test.

The volume of the graduated neck of the milk test bottle from 0 to 10 is 2 c.c.

2 c.c. of melted fat (140 deg.) F. at a sp. gr. of .9 (2 × .9) = 1.8 grams. The ratio of 1.8 to 18 is 1 to 10, or 1.8 is 10% of the original weight of the milk. This is why the neck is divided into 10 equal spaces, each space being 1%, and why that weight or volume of milk is taken. The smallest subdivisions are .2%.

Principles of the Babcock Test.—The method is based upon the action of two agents: (1) Strong sulphuric acid upon the constituents of the milk serum; and (2) Centrifugal force.

1. Sulphuric acid acts chemically and physically as follows:
   - (a) Upon the non-fatty solids, dissolving them and setting free the fat globules.
   - (b) Upon the water and organic solids generating so much heat that the minute fat globules lose their individuality and run together forming larger globules and facilitating more rapid and complete separation.
   - (c) Sulphuric acid, being more than twice as heavy as milk fat, increases the difference in specific gravity between it and and the liquid surrounding it, which also aids in the separation of the fat.
2. Centrifugal force completes the separation. When the bottles are whirled in the machine they assume a horizontal position. Centrifugal force acts more strongly upon the heavier acid-milk serum portion, which is forced to the outside (bottom of bottle) and the lighter fat comes to the centre (neck of bottle).

Speed of Machines.—The following is a table of the speed required to give a complete separation in the Babcock machines:

Diameter of Wheel	R. P. M.
10 inches	1074
12 "	980
14 "	909
16 "	848
18 "	800
20 "	759
22 "	724
24 "	693

SAMPLING UNDER ABNORMAL CONDITIONS.

Frozen Milk or Cream.—It is essential that the liquid and frozen parts be warmed and mixed thoroughly before a sample is taken. Do not use too high a temperature, as it will cause the fat to separate in the form of oil. Immersing in water at about 95 deg. F. is most satisfactory.

Sour Milk.—Sour milk should not be tested unless such testing is absolutely necessary. It is difficult to sample sour milk because the casein has been precipitated and much of the fat is locked up in the particles of curd, making an even distribution of the fat impossible. A strong alkali, such as powdered caustic soda, or caustic potash, may be used to restore the consistency of sour milk. Add a small quantity, mix, and allow to stand until the particles of curd disappear. In testing such a sample add the acid carefully a little at a time.

Partially Churned Milk or Cream.—Churned milk or cream should not be tested if it can be avoided. When it is absolutely necessary to test such a sample it should be heated to 100 to 110 deg. F., thoroughly mixed, and the sample drawn quickly, and, in the case of milk, cooled in the test bottle to 60 deg. F., before adding the acid. The same procedure will serve when the milk is covered with a thick leathery cream. Results of such testing should be regarded as only approximately correct.

COMPOSITE SAMPLES, SAMPLING AND TESTING.

A true composite sample consists of representative, proportionate portions of milk of several deliveries from the same source, kept by the use of a preservative, the object being to obtain the average test of the Patron's, or cow's milk, without the labor and expense of testing each lot separately. This method is practised by Cheese Factories, Milk Plants and by Cow-Testing Associations.

A tightly stoppered bottle, with name or number attached, should be provided for each Patron. They may be numbered, using bicycle enamel, or the glass may be roughened with a file and the number put on with pencil. A convenient way is to use a gummed label and cover it with two or three coats of shellac to prevent injury when washing; or, better still, use aluminum bands bearing the Patron's number. Jars fitted with ground glass stoppers are best. Paper caps are not satisfactory and rubber stoppers are preferred to cork or wooden ones. The bottles should be arranged in systematic order convenient to the weigh-stand. The bottles and stoppers must be thoroughly cleaned and sterilized after each period of use. If troubled with mold it is well to treat the bottles and stoppers with formalin. Moldy samples are not reliable and should not be tested.

Several kinds of preservatives are used, the one giving most satisfactory results being a mixture of three parts of potassium bichromate to one part of corrosive sublimate, (mercuric bichloride). Potassium bichromate may be used alone if the samples are not kept longer than two weeks, enough being added to give the milk a lemon-yellow color. If the mixture is used, approximately as much as will lie on a ten cent piece, will usually preserve a pint for one month. Tablets are now prepared and sold by the Dairy Supply Houses, which may be used with good results. The amount of preservative required will depend upon the condition and size of the sample, the length of time over which the testing period extends, the temperature at which the sample will be kept, and the strength of the preservative. Avoid using an excess of preservative. At the end of the period the mixture of samples may be tested by the Babcock method, and if the work of sampling has been done properly, the result should be an average percentage of the fat in the different lots of milk.

Sampling.—The cone shaped or ounce dipper is commonly used for sampling owing to its greater convenience. While this method is not mathematically correct, the results tending to be less correct than where aliquot portions are taken as with the milk thief or graduated pipette, experimental data show that the results average practically the same. The sample is taken from the weigh can as it has been shown that such a sample is representative of the average quality of the milk, due to agitation on the wagon and pouring into the weigh can.

Each time a fresh sample is added the bottle should be given a gentle rotary motion. Do not shake violently. The jars should be kept tightly stoppered at all times, in a cool place and not exposed to direct sunlight or to frost.

To prepare composite samples for testing, heat the sample to 105 to 110 deg. F. by placing in warm water to loosen the fat adhering to the sides of the jar, then mix thoroughly by pouring. The temperature of the sample should not be allowed to become high enough to melt the fat into an oil as it is next to impossible to obtain a representative sample when in that condition. When thoroughly mixed, immediately transfer 17.6 c.c. to the test bottle and cool to 60 deg. F. before adding the acid. Usually slightly less than 17.5 c.c. of acid will be required. The right amount is being used when the fat column is clear and of a golden yellow color. Whirl at the proper speed for 5 minutes then add hot soft water at 160 to 170 deg. F. to the base of the neck and whirl for 2 minutes. Fill up to the 8% mark with hot soft water and whirl again for one minute. Read at 140 deg. F. measuring from the bottom of the fat column to the top of the meniscus. See Sec. 11 of "Details" for directions when washing test bottles.

Cow-Testing.—If calculating the monthly production of a cow on test, when weighings are taken on 10th, 20th and 30th of the month, and a composite sample taken of the milk, proceed as follows:

The weighings of milk on the three days are:

10th.	A.M.	20.5	pounds
	P.M.	21.0	"
20th.	A.M.	22.0	"
	P.M.	21.0	"
30th.	A.M.	19.0	"
	P.M.	19.5	"
Total		123.0	"=in three days

123÷3.=41 pounds daily average production.

41×30=1230 pounds, total production for month.

The composite sample tested 3.4 per cent fat.

1230×.034=41.82 pounds, which is the yield of fat for the month.

To obtain the approximate yield of butter from this amount of fat increase the fat by the factor 1/6

1/6 of 41.82= 6.97 pounds=estimated overrun.
6.97+41.82=48.79 pounds of butter.

To find the average test of different weights of milk of varying percentages of fat:

230 lbs. milk testing 4.1% fat = 9.43 pounds fat
175 lbs. milk testing 3.2% fat = 5.60 pounds fat
184 lbs. milk testing 3.7% fat = 6.808 pounds fat
589 lbs. milk contains ....21.838 pounds fat

$$\text{Average test} = \frac{21.838 \times 100}{589} = 3.747 \text{ per cent.}$$

THE SPECIFIC GRAVITY OF MILK AND THE LACTOMETER.

The specific gravity of a substance is a ratio between the weight of a given volume of the substance and the weight of a given volume of some other substance taken as a standard. The standard for liquids is water and its specific gravity is taken as one. Milk is slightly heavier than water, and the specific gravity of normal milk averages 1.032, although, normal milk from individual cows may range between 1.027 and 1.035. The addition of water to milk lowers the specific gravity because water is lighter than milk. If the cream is partially removed from milk the specific gravity will be increased because the fat is the lightest component of milk.

The specific gravity of liquids is readily measured by an instrument known as a hydrometer, the use of which is based on the fact that when a solid body floats in a liquid, it displaces an amount of liquid equal in weight to the weight of the floating body. Thus it sinks deeper in a light than in a heavy liquid because it takes a larger volume of the light liquid to equal the weight of the floating body. Hydrometers have been graduated as a result of experimentation, so that the specific gravity of liquids under observation may be read at the point where the scale is even with the upper surface of the liquid. When a hydrometer has a scale especially graduated to the limits of the specific gravity of milk, it is called a **lactometer.** Of the various lactometers made, only one, "The Quevenne", will be mentioned here owing to its extensive use in Canada.

The Quevenne lactometer is standardized at a temperature of 60 deg. F. If the milk to be tested varies from this, corrections may be made according to the following rule: For each degree in temperature **above** 60, add .1 to the lactometer reading, and for each degree **below** 60, substract .1 from the lactometer reading. This rule is practically correct, if the temperature is kept within a range of from 50 deg. to 70 deg. F. It can be readily recalled when we remember that the density of milk **increases** with a **reduction** of temperature and decreases with a rise in temperature. The scale of the lactometer is graduated from 15 to 40, and indicates a specific gravity of from 1.015 to 1.040.

Note.—The correct lactometer reading (or L.R. at 60 deg. F.) + 1,000 ÷ 1,000 indicates the specific gravity.

The reading should be taken soon after placing the instrument in the milk; if cream be allowed to rise on the milk, the reading will be too high, as the bulb of the lactometer will be floating in partially skimmed milk. Milk should be cooled and allowed to stand some time (one to three hours) after being milked before taking the lactometer reading. Otherwise the readings will be too low.

COMPOSITION OF MILK

The composition of milk is about as follows:

Fat	3.6	per cent.	
Casein	2.5	"	solids 8.9 not fat.
Albumin	.7	"	
Sugar	5.0	"	
Ash	.7	"	
Water	87.5	"	
	100.00		

It is the solids-not-fat in milk that cause its specific gravity to exceed that of water, and consequently its lactometer reading to be greater.

TESTING MILK FOR SOLIDS.

As a result of extended studies on the relations existing between the specific gravity of milk, milk-fat and milk-solids, several formulas have been prepared by means of which it is possible to calculate the total solids of milk for rapid and reasonably accurate work when the percentage of fat and Quevenne lactometer reading are known.

The following three are in general use:—

(1) $\frac{L+F}{4}$ = S.N.F. in which L is the lactometer reading and F the per cent. of fat in the milk. .... (Troy)

(2) $\frac{L+.7\ F}{3.8}$ = S.N.F. .... (Babcock)

(3) $\frac{1}{4}\ L+.2\ F+.14$ = S.N.F. .... (Babcock)

The total solids may be obtained by adding the fat reading to the solids-not-fat.

The following examples will illustrate how these formulas operate using No. 1 formula:

Suppose the Q. lactometer reading of a sample of milk were 32 at 60 deg. F. and the fat reading was 3.5 per cent. What is the percent solids-not-fat and total solids?

$\frac{L+F}{4}$=S.N.F.

$32+3.5=35.5$

$35.5\div4=8.885\%$ S.N.F.

$8.885+3.5=12.385\%$ T.S.

DETECTION OF ADULTERATION OF MILK.

By the use of the Babcock Test in conjunction with the lactometer it is possible to determine both the nature and the extent of adulteration in milk. The percentage of fat in milk varies and can also be changed by the skimming, therefore, the lactometer alone is of little use in determining adulterations. The solids-not-fat are fairly constant, and thus afford a means of detecting adulterations.

The following indications as to the kinds of adulteration of milk will serve as a guide in the detection of same.

Watering is indicated by:
- Low lactometer reading.
- Low per cent. fat.
- Low per cent. solids-not-fat.

All three being reduced in equal proportion.

e.g., L.R. 25; S.N.F. 6.75 per cent.; fat 2.5 per cent.

Skimming is indicated by:
High lactometer reading.
Low per cent. fat.
High or normal per cent. solids-not-fat.
e.g., L.R. 34; S.N.F. 9 per cent,; fat 2.7 per cent.

Watering and skimming are indicated by:
Lactometer reading may be normal or slightly low.
Low per cent. fat.
Low per cent. solids-not-fat.

The fat is reduced in greater proportion than either the lactometer reading or the solids-not-fat.

e.g., L.R. 27; S.N.F. 6; fat 2 per cent.

The following sample will illustrate a method to calculate the percent adulteration:

Before adulteration a sample of milk had 4.4 percent fat and 9 percent S.N.F.. After adulteration the sample contained 2.4 per cent fat and 7 percent S.N.F.

(1) What percent of extraneous water was added?
(2) What percent of the fat was reduced by watering?
(3) What percent of the fat was removed by skimming?

1. Since there was 9 per cent S.N.F. before adulteration, and 7 percent S.N.F. after adulteration the reduction in the percent S.N.F. was 2, which is equivalent to—

   $\frac{2 \times 100}{9}$ or 22.22% of the original S.N.F. content, and

   since the reduction in the precent S.N.F. was caused by the addition of water 22.22% of water must have been added to the milk.

2. The original sample of milk had 4.4% fat and after adulteration, 2.4% fat. Therefore, the reduction amounted to 2, which equals—

   $\frac{2 \times 100}{4.4} = 45.45\%$ of the original fat.

3. When milk is watered all of the solids are reduced in the same proportion. It has been shown that the S.N.F. was reduced 22.22% by the addition of water, therefore, according to the above rule, the fat must have also been reduced 22.22% by watering. But the total fat removed has been shown to be 45.45%, therefore—

   45.45—22.22=23.23=percentage of fat removed by skimming, hence, the 22.22% of water added to the milk, reduced the S.N.F. from 9% to 7%, and also, proportionately, the fat content from 4.4% to 3.43%; while the act of skimming removed 23.23% of the original fat, and lowered the test from 3.43% to 2.4%.

CREAM TESTING.

Cream Test Bottles.—In testing cream specially graduated test bottles are required. Many different styles of bottles are on the market but those most commonly used are the 6½ inch 50%, 9 gram bottle and the 6½ inch, 18 gram bottle graduated to read 40 or 50 per cent. The 9 gram bottle seems to be used more extensively at the present time than the 18. The smaller the bore of the neck the less error there is likely to be in reading. However, in using the 9 gram bottle any error in weighing will produce twice as great an error in the test as the same error in weighing will produce in the 18 gram bottle. Which bottle one shall use is largely a matter of personal preference, but to secure uniform results all bottles used in any plant should be uniform as to construction, graduation and weight of sample.

Why Cream is Weighed for Testing.—The Babcock test is based on weight and it is simply for convenience that milk is measured since the pipette delivers approximately the same weight from time to time. Measuring cream for testing is inaccurate for the following reasons:

(a) Variation in richness of cream,
(b) Gas and air in the cream,
(c) Cream adhering to the walls of the pipette.

"The Dairy Products Act, 1927" provides that a sample of cream taken for testing shall weigh 9 or 18 grams.

Cream Scales.—Cream scales must be accurate and sensitive to .03 grams. They should rest on a firm level table, be properly adjusted and kept in good working order. They should be kept dry and protected from corrosive influences such as sulphuric acid, salt, etc. During operation the scales should not be exposed to drafts and the weighings must be made accurately.

Balances of large capacity and holding a large number of bottles are not as sensitive as balances of small capacity and holding few bottles only. Other factors being the same the one bottle scale is the most accurate scale. However, two-bottle or four-bottle scales if properly constructed, in good working condition, and operated carefully, answer all practical purposes.

Sampling Cream.—One of the most common causes of incorrect cream tests lies in the inaccuracy of the cream sample. Frequently, at the time of sampling, cream is in no condition to be sampled correctly, consequently it should receive the proper care on the farm. The patron should be encouraged to deliver cream testing from 30 to 40 per cent fat and in as sweet a condition as possible.

When the cream is mixed by stirring, the stirring must be done thoroughly; simply giving the cream a few dips with the sample dipper is not sufficient. The stirrer must be worked to the bottom of the can several times and the contents of the can must be thoroughly agitated. A sample is then transferred to a suitable jar having a tight fitting stopper, and with the patron's number attached.

Making the Test.—Cream samples should be warmed sufficiently to pour freely. It is well to have them arranged in numerical order in a rack with a perforated bottom so that the whole "run" may be warmed at once in a water bath for the purpose. The test bottles should be numbered to correspond with the sample bottles. As previously pointed out have the cream scale on a firm level table away from drafts. The scale should always be locked when adjusting bottles or weights. Balance the bottles carefully and place the weight, which must be Government stamped, on the opposite pan to bottle No. 1. Mix the sample thoroughly by shaking or pouring several times, then transfer the cream to the test bottle, by means of a pipette, until the scale balances exactly. Either of the following methods may then be followed.

Method 1.—When the weighing is completed the next step is to add the acid. Commercial sulphuric acid, specific gravity 1.82—1.83, should be used. When adding the acid incline the bottle and revolve in order to wash the neck free from particles of cream. Add acid until the mixture and acid, after mixing, has assumed a chocolate-brown color. Mix by giving a gentle rotary motion until all lumps disappear, care being taken not to spill any of the contents, then add soft water at 160-170 deg. F. almost to the neck. Transfer the bottle to the machine, counterbalance it, then whirl for five minutes at proper speed. Add the hot, soft water until the liquid column approaches the top graduation of the scale, then whirl for 2 minutes at the same speed. Remove the test bottles to, and hold in, a water bath at 140 deg. F. for at least 3 minutes, and, with the aid of dividers, measure the fat column from its base to the bottom of the meniscus. If desired, **immediately before reading,** a few drops of standard red reader may be added, allowing it to flow down the side of the neck. This removes the meniscus leaving a straight line, which is sharply defined and readily seen. Measurement is made to this line. (A modification of this method, for the 9 gram bottle only, is to add a few c.c. of warm water before adding the acid. Usually clearer readings are obtained but more acid is required. The test is completed as above.)

Method 2.—After the cream has been weighed into the test bottles add acid until the mixture of cream and acid, after mixing, assumes the color of coffee with cream in it. Mix as in Method 1, balance in the machine, then whirl for 5 minutes at proper speed. Fill to the base of bottle neck with soft water at 160 - 170 deg. F. and whirl for 2 minutes. Add the hot, soft water until the column approaches the top graduation of the scale and whirl 1 minute. Adjust the temperature and measure the fat column as in Method 1.

Whichever method is followed, the fat column, at the time of reading, should be perfectly clear, of a golden yellow to amber color, and free from visible suspended particles. See section "Abnormal appearance of fat column", for cause of abnormal tests. Such tests should be rejected as the reading usually is indistinct and misleading. See also, "Details of Babcock Test," for directions for washing test bottles.

COMPOSITE CREAM SAMPLES.

Composite samples of cream, representing portions of successive shipments or deliveries from the same Patrons, generally prove unsat- the proper amount of preservative added, and kept in tightly stoppered isfactory. They may yield correct tests when taken with special care, bottles stored in the cold room. **Under average Creamery conditions, however, composite sampling of cream cannot be recommended.** It is difficult to obtain representative, proportionate portions, and the general practice of keeping the sample jars on the shelves of the warm receiving platform, invites evaporation of moisture, causing such samples to yield high and misleading tests. The general practice in Ontario is to follow the method of sampling and testing each individual can of cream as delivered.

TESTING SKIMMILK, BUTTERMILK, AND WHEY.

When testing these by-products, use a double neck bottle. Those having a total graduation of 5% with smallest subdivisions of .01%, and with the two necks joined together, extending perpendicularly from the centre of the bottle are preferable and the most durable. It is very important that all glassware be perfectly clean, as a small amount of fat in the pipette or bottle would seriously affect the results. Obtain a sample of skimmilk from the separator about midway of the 'run' and hold an hour before testing; or, obtain after mixing the whole quantity. Buttermilk or whey samples are obtained approximately midway of the flow from the churn or vat. Buttermilk if left standing any length of time should be mixed very thoroughly before sampling because the curd, which contains the bulk of the fat, separates out very quickly.

The results of testing buttermilk and skimmilk by the Babcock method should not be relied on absolutely for accuracy, but they may serve as a convenient guide, showing the operator whether these by-products contain little or much fat. It is claimed however, for the Mitchell test that it compares very favorably with a chemical analysis of buttermilk and skimmilk, while the Babcock test gives satisfactory results with whey.

Babcock Method.

1. Measure 17.6 c.c. of a well mixed sample at 60 to 70 deg. F. and deliver into a double neck bottle.
2. Add 20 c.c. commercial sulphuric acid, sp.gr. 1.82 to 1.83 at the same temperature. (approx. 12 c.c. for whey.)
3. Mix by giving a gentle rotary motion.
4. Whirl at the proper speed for 5 minutes.
5. Add soft water at 160 - 170 deg. F. almost to the neck and whirl for two minutes.
6. Fill up with hot water and whirl one or two minutes.
7. Read at 140 deg. F. from the lowest to the highest points.

"Rigorous" Babcock Method.

1. Measure 8.8 c.c. of a well mixed sample of buttermilk or skimmilk at 60 - 70 deg. F. and deliver into a double neck bottle.
2. Add about 12 c.c. sulphuric acid, sp.gr. 1.82 - 1.83 at the same temperature.
3. Mix by giving a gentle rotary motion.
4. Whirl at high speed for 15 - 20 minutes.
5. Add soft water at 160 - 170 deg. F. almost to the neck and whirl ten minutes.
6. Fill up with water and whirl five minutes.
7. Read at 140 deg. F. from the lowest to the highest points. Double the observed reading to obtain the per cent fat.

Mitchell Test.—(Acid-Alcohol, or American Association Test)

1. Place the chemicals and buttermilk or skimmilk in the test bottle in the following amounts and order indicated:
    2 c.c. of normal butyl alcohol,
    8.8 c.c. of well mixed buttermilk or skimmilk at 60 - 70 deg. 7 to 9 c.c. com. sulphuric acid, sp. gr. 1.82 - 1.83 at same temperature.

2. Mix by giving a gentle rotary motion.
3. Whirl for 6 minutes at the proper speed.
4. Add soft water at 160 - 170 deg. F. almost to the neck and whirl two minutes.
5. Add the balance of the hot water to float the fat into the neck and whirl two minutes.
6. Read at 140 deg. F. from the lowest to the highest point. Double the observed reading to obtain the per cent of fat.
7. In cleaning the test bottle—especially if there be any deposit, first add some luke-warm water and to this add sulphuric acid—never the reverse. Rinse the bottles well with this mixture and then with hot water.

BUTTER—MOISTURE TEST.

Since it is unlawful to manufacture or to sell butter in Canada containing more than 16% of water, a simple, rapid and reasonably accurate means of determining the percentage of water in butter has become a necessity for the guidance of the buttermaker as well as for inspection purposes.

The method most commonly used in Canada at the present time, consists of the evaporation of the water from a definite weight of butter and the determination of the percentage of water from the loss in weight. Scales have been constructed to give the per cent. of water directly from the beam used to balance the scale after the water is evaporated, when a definite weight of butter (10 grams.) is used as a sample.

Sampling and Preparing Butter for Testing.—A sample must be secured which represents as closely as possible the average quality of the quantity to be tested. In taking a sample from the churn the surface should be cut away at several places and small samples taken from the interior of the mass—avoid water pockets. In sampling solids, a long trier is used, taking segments from different parts of the plug. In the case of pound prints a good method is to cut out a quarter section of the print cutting lengthwise of the print. The quarter section may be cut into two pieces, one of which is taken as a sample. In each of the above instances the small samples should be placed in a clean, dry glass jar and covered tightly, unless the test is being made immediately.

Special preparation of the samples is somewhat of an open and debatable question. When not testing immediately after sampling from prints or solids, especially if from more than one package, or when sampling from the churn, particularly for a preliminary test, special preparation is necessary. This preparation of the sample requires considerable care. The jar is placed in warm water and the butter stirred with a knife or spoon until it is reduced to a thick creamy consistency, all lumps having disappeared. The water **must not** be too hot, not over 105 deg. The butter should not be melted to an oil, as the water and salt will settle to the bottom and it is then very difficult to get a representative sample from the jar for testing. It is very difficult to get duplicate tests to agree when the sample becomes oily. Taking the samples from the churn and whipping to a paste without heating is permissible.

Making the Test.—The moisture scale should rest on a firm level table, be kept as clean and dry as possible, and during operation it should not be exposed to drafts. A good plan is to build a small cupboard, fitted with a slide door, around the scale. The weighings must be made accurately.

When using the "Torsion" scale it is first balanced or levelled by adjusting the thumb screws, the small tare weight being at zero, and the large one at the extreme right. "Success" type of scale should be level also. It is advisable to use a spirit level.

The aluminum cup should be cleaned thoroughly and wiped dry. It is then dried thoroughly over the flame and placed on the pan of the scale. When cool it is balanced by adjusting the weights on the tare beam, and then exactly 10 grams of butter are weighed in from the prepared sample. The cup is now heated slowly over a low flame to evaporate the moisture, giving it a constant gentle agitation to prevent charring and to hasten the escape of the moisture. Do not splash any of the fat out of the cup. Continue heating until the foam subsides and a slightly brown color appears. Further heating would result in driving off some of the volatile fats with a corresponding incorrect test. The cup is cooled and re-weighed. Re-weighing the hot cup and deducting the difference between hot and cold balancings is permissible and saves time. The "percentage" weights are adjusted until the scale balances. The position of these weights indicates the per cent of moisture in the butter.

BUTTER—SALT TEST.

This test is based upon the fact that salt and silver nitrate combine with each other in definite proportions. The silver nitrate solution is prepared by dissolving 2.906 grams of chemically pure silver nitrate crystals in 1000 c.c. (1 litre) of distilled water. 1 c.c. of this solution will neutralize .001 gram salt (sodium chloride). This solution must not be exposed to the sunlight as it will weaken. The potassium chromate solution, which is used as an indicator, is prepared by dissolving 7.25 grams of potassium chromate in 25 c.c. of distilled water.

Making the Test.—In order to make the test it is necessary to have a burette graduated to .1 c.c.; a stand for the burette; a 25 c.c. pipette; a glass or porcelain cup or beaker and stirring rod, a dropper bottle for the indicator; a 250 c.c. flask and a pint milk bottle.

If a moisture test has been made, using 10 grams of butter, the residue may be used for the salt test. If no moisture test has been made a sample is obtained and prepared as previously described for the moisture test. Dry and balance the moisture cup and weigh 10 grams of the prepared sample, then melt the butter to an oil. Fill the 250 c.c. flask to the mark with distilled water at about 120 deg. F. (If distilled water is not obtainable tap water may be used by making a blank test of it and deducting the per cent. of salt in the water from the salt test obtained.) Transfer the butter from the cup to the pint bottle rinsing the cup with the water from the flask Another method is to weigh 10 grams of prepared sample on a small piece of parchment paper which has been previously balanced. The paper and butter are transferred to the pint bottle. The pint bottle containing the melted butter and 250 c.c. of water is then shaken thoroughly to ensure an even distribution of the salt throughout the water. It is then allowed to stand until the fat rises to the surface. Measure 25 c.c. of the clear salt solution, transfer to the cup or beaker and add a few drops of indicator. Fill the burette with the silver nitrate solution then add it slowly stirring constantly until a permanent faint reddish brown color appears. Each c.c. used represents .1% salt in the butter. Thus if 20 c.c. were used the butter would contain 2.0% salt.

THE FARRINGTON TEST FOR FAT IN BUTTER.

Apparatus Required:

Farrington test bottles
Bottle support for balance
Mixing and pouring cup
Pocket adapters for centrifuge
Four-bottle metal holder
Spatula for mixing sample
Balance
Water Bath
Babcock centrifuge.

1. Obtain a representative sample of the butter by removing small portions from the package, jar or churning of butter, with a tryer, knife or spoon. Place in a special mixing and pouring cup if to be tested immediately; or, in a glass bottle having a tight fitting cover if to be held for future testing.

2. Place the cup containing butter in a water bath at 100 deg. F. long enough for the butter to soften and have the consistency of heavy cream. (The butter should never be heated to separate fat from brine.)

3. Each test bottle should be clean, weighed empty, and the weight recorded each time a test is made.

4. The prepared sample of butter is poured into the glass butter test bottles. The test bottle, which has a capacity of 50 grams is filled to about the 47 gram mark and then weighed. By substracting the weight of the empty bottle, the exact weight of the butter in the bottle is obtained.

5. The bottles are placed in a metal holder and placed in a water bath having a temperature of 160 deg. F. for a few minutes. The butterfat melts and rises to the surface while the brine settles to the bottom; the casein or curd is more or less mixed through the fat, or stands in a layer between the fat and the brine. This preliminary heating helps to contract the curd and makes a clearer reading of the lower line of the fat column.

6. Place the bottles in a Babcock centrifuge in pockets where the metal adapter has first been placed, and whirl for 15 minutes at the speed indicated.

7. Remove from the centrifuge and replace in metal holders, and again set in a water bath at about 140 deg F. for 10 minutes, so as that the fat will be a uniform temperature.

8. If the line between the brine or water and the fat is not clear a few drops of hot water or of strong brine solution may be added; this will drop through the fat and form a clear layer between fat and casein at the bottom of the fat column. Sometimes it is advisable to centrifuge

a second time to obtain a clear line between the fat and the liquid below. The test bottle should be nearly horizontal in the centrifuge during the whirling so that the lower end of the fat column will be straight.

9. Raise the bottles carefully out of the water bath and take the reading of the graduated tube at the top and also at the bottom of the fat column. Do not allow the fat to get cold. The difference between these readings equals the grams of butter-fat.

To Calculate Per cent Fat.

E.G.	Weight of test bottle and butter	106.9 grams
	" " empty test bottle	58.9 "
	Weight of butter taken	48.0 "

Reading of test bottle after whirling 15 minutes and holding 10 minutes at 140 deg. F.

Upper reading of fat column	48.0 grams
Lower reading of fat column	8.5 "
Amount of fat in sample	39.5 "

This 39.5 grams of fat is multiplied by 100 and the product divided by the grams of butter weighed into the test bottle, or 48.0, and gives 82.3 as the per cent. of fat in butter.

ACID TEST FOR BUTTER

(Bouska and Brown of Beatrice Creamery Co., Chicago, Ill.)

Reagents.

1. **Phenolphthalein**—made up at the rate of two ounces dissolved in one gallon of denatured alcohol. (Same as for testing acidity in milk or cream.)

2. **Alcohol Ether**—Mix at the rate of 25 c.c.'s of ether in 100 c.c.'s of denatured alcohol. (This reagent is slightly acid, and the acidity should be ascertained for 20 c.c.'s of reagent. This is called a blank test.)

3. **Standard Alkali Solution** NaOH—N|9; N|10 or N|20 may be used, the latter will afford the closest reading.

Manipulation.

1. Gently melt 10 grams of butter in a suitable cup or beaker
2. Add 1 c.c. of phenolphthalein, and 20 c.c.'s of alcohol ether reagent.
3. Carefully run in standard alkali (stirring) until a faint permanent deep pink color appears.
4. Read burette and deduct blank test from reading. If N|9 alkali is used and 10 grams of butter taken, each c.c. equals 0.1 per cent. of acid.

If N|10 alkali is used and 9 grams of butter taken, each c.c. equals 0.1 per cent. of acid.

If N|20 alkali is used and 9 grams of butter taken, divide the read- two, and the quotient then has the same value as deci-normal.

CHEESE-FAT TEST

1. Obtain a representative sample by taking plugs from different parts of the cheese.
2. Cut the sample as finely as possible in a glass jar.

3. Weigh 2 to 5 grams in a whole milk bottle or up to 9 grams in a cream bottle.

4. Add sufficient warm water at about 120 deg. to make about 18 grams in the bottle—Do not add too much water.

5. Keep the sample warm and mix **carefully** until the cheese and water form an emulsion.

6. Add commercial sulphuric acid a little at a time and mix until all the curd is dissolved and the mixture is a dark chocolate color.

7. Add hot soft water at 160 to 170 deg. to the base of the neck and whirl for five minutes at proper speed.

8. Add the balance of hot water and whirl for 2 minutes.

9. Read at 140 deg. from the bottom of the fat column to the bottom of the meniscus, or read with the use of Red Reader.

10. The per cent of fat is obtained by multiplying the reading by the number of grams for which the bottle is constructed and dividing the result by the number of grams used in making the test.

DETERMINATION OF THE PER CENT. OF WATER IN CHEESE.

The percentage of moisture in cheese is determined by evaporating the moisture from a definite weight of cheese and calculating the per cent. from the loss in weight. The ordinary butter moisture scales may be used for weighing the sample.

The most satisfactory method of determining the percentage of moisture in cheese is by means of the high pressure steam oven which is constructed of cast-iron having the sides double jacketed. The space within the jacketed walls is fitted with a steam inlet, and an outlet to allow the condensed water to drain out. The interior or chamber is fitted with a perforated rack on which to place the samples and which permits free circulation of air around the samples. The temperature is regulated by adjusting the steam pressure applied in the hollow walls, and is read by means of a thermometer which extends into the chamber.

The taking and preparing of a sample of cheese for a moisture test is outlined in the fat test for cheese and holds good in this case as well. The sample is thoroughly cut up, mixed and ten grams are weighed in an aluminum dish which has been thoroughly dried and balanced on the scale previously. The cheese must be spread as evenly as possible over the aluminum dish and as quickly as possible so as to avoid any escape of moisture due to evaporation. The ten grams sample is now placed in the oven, the door closed and 45 to 50 pounds steam pressure applied. This should give a temperature of 225 deg. F., to 250 deg. F., which is sufficient. The sample is heated until all the moisture has been evaporated This is determined by successive weighings followed by further heating in the oven. The sample must always be allowed to cool before each weighing. When the sample ceases to lose weight, the evaporation of moisture has been completed. Ascertain the percentage of moisture from the loss in weight. For example:

If 10 grams of cheese lose 3.8 grams of moisture, 100 grams would lose

$\frac{3.8}{10} \times 100 = 38$ per cent. The sample therefore contains 38 per cent. moisture

Testing Ice Cream for Fat

Babcock-Gerber.

Method 1*.—1. Weigh 9 grams of well mixed, melted ice cream or mix, into a 9 gram, 20 per cent ice cream test bottle.

2. Add 9 c.c. of water and 1.8 c.c. of amyl alcohol.

3. Mix thoroughly.

4. Add 17.5 c.c. of diluted, commercial, sulphuric acid, (94 c.c. of acid to 6 c.c. of water for chocolate ice-cream, or 87 c.c. of acid to 13 c.c. of water for other flavors,) in three proportions and mix thoroughly after each addition of acid, and finally give samples a vigorous shaking. (To obtain a clear fat column this is important).

5. Centrifuge for five minutes.

6. Add hot, soft water to bring contents up to the bottom of the neck of the bottle.

7. Centrifuge for two minutes.

8. Add hot, soft water to bring the bottom of the fat column well within the neck of the bottle.

9. Centrifuge for one minute.

10. Place bottles in a hot water bath at a temperature of 135 deg. F. to 140 deg. F. for five minutes.

11. Remove each bottle as it is to be read, add Standard Red Reader, and read the per cent of fat with dividers.

1. Journal of Dairy Science. Vol. IX, No. 3, pp 278.

(Fisher & Walts, Storrs, Conn. Bull. 131)

Method No 2.—1. Weigh 9 grams of a representative sample of melted ice cream, or mix in a whole milk bottle, at a temperature of 50 to 70 deg. F.

2. Add 10 c.c. of 95% ethyl alcohol and 9 c.c. of commercial, sulphuric acid, specific gravity 1.82 to 1.83.

3. Mix thoroughly.

4. Whirl at the proper speed for 5 minutes,

5. Fill to the base of the neck with soft water, 160 - 170 deg. F. and whirl 2 minutes.

6. Add hot, soft water to float the fat well within the graduated neck, and whirl 1 minute.

7. Place in a water bath, 140 deg. for a few minutes and read. Double the observed reading to obtain the percentage of fat.

MODIFIED BABCOCK METHOD FOR FAT IN WHOLE MILK POWDER.

Method No. 1.—1. Weigh 2.5 grams of powder into a clean, dry 10 per cent milk bottle. Use a clean glass funnel to transfer the milk to a bottle.

2. Add 31 c.c. of sulphuric acid diluted by bringing 395 c.c. of concentrated sulphuric acid up to 1 litre.

3. Shake the mixture and place in boiling hot water shaking at intervals until all is dissolved.

4. Add 12 c.c. of commercial acid, mix well, and proceed with the remaining details of the test as for whole milk.

5. Multiply the result by 7.2 to obtain correct per cent fat.

Method No. 2.—1. Dissolve 10 grams of milk powder in 90 c.c.'s of water. Warm and mix until a complete solution is effected.

2. Measure 17.6 c.c. into a whole milk bottle.
3. Proceed as for testing whole milk.
4. Reading, multiplied by ten, equals the percentage of fat.

Legal Standard— Not less than 95% milk solids.
Not less than 26% milk fat.

EVAPORATED OR UNSWEETENED CONDENSED MILK.

1. Weigh 5 grams of well mixed milk into a whole milk test bottle.
2. Add 17.5 c.c. water.
3. Add 17.5 c.c. sulphuric acid and mix thoroughly.
4. Centrifuge at the standard speed for 5 minutes.
5. Mix equal proportions (by volume) of sulphuric acid and water in glass beaker.
6. Fill the bottle to slightly below the bottom of the neck, with hot diluted acid solution.
7. Centrifuge for 2 minutes.
8. If the fat collected at the base of the neck be not clear, shake the bottle until the curdy matter is dissolved.
9. Fill the bottle to about the 8 per cent mark with hot, soft or distilled water.
10. Centrifuge for one minute and read at 140 deg. F.
11. Reading x 3.6 equals the percentage of fat. Measuring 4.3 c.c., rinsing pipette twice, and delivering each rinsing into the test bottle, gives fairly accurate results.

Legal Standard— 25.5 per cent milk solids.
7.8 per cent milk fat.

SWEETENED CONDENSED MILK.

Weigh 40 grams of milk into a beaker and add to this 60 c.c. of water. Mix until the milk is completely mixed with the water.

1. Weigh 18 grams of the 40% milk solution, into a whole milk bottle.
2. Add 4 c.c. Commercial Sulphuric Acid (1.82—1.83, sp. gr)
3. Mix until the acid is thoroughly mixed with the milk.
4. Centrifuge for 6 minutes at the maximum speed of the centrifuge. (Centrifuge must run smoothly).
5. Stop the centrifuge gradually, and remove bottles carefully, so as not to break the layer of floating curd.
6. Decant the clear whey by inclining the bottle.
7. Add 2/3 of a 17.6 c.c. pipette of water and shake until the curd is well broken up.
8. Add 4 c.c. acid, mix, centrifuge and decant as before.
9. Add 17.5 c.c. water and 17.5 c.c. of sulphuric acid, and complete the test in the usual way as for testing whole milk.
10. Reading x 2.5, equals the percentage of fat.

Legal Standard—
8 per cent fat.
28 per cent milk solids.

HART CASEIN TEST.

This is a simple and accurate test introduced by Dr. E. B. Hart of Wisconsin, U.S.A., in which the casein is precipitated by dilute acetic acid and the fat is dissolved by chloroform. The bottle is constructed with the graduated stem on the lower end and the bulb on the upper end, the scale being similar to that of the 10% Babcock milk test bottle.

To Make a Test.

1. Add the chemicals and milk to the test bottles in the quantities and order given—having the temperatures as near 70 deg. as possible.

   2 c.c. good quality chloroform
   20 c.c. of a .25% solution of acetic acid
   5 c.c. of a well mixed sample of **sweet** milk.

2. Place the thumb over the opening of the bottle and agitate by inverting for 15 to 20 seconds, using a watch to take the time.

3. Balance the bottles in the centrifuge and whirl for 7½ to 8 minutes at a uniform speed of 2000 R.P.M. for a 15 inch diameter machine. It is well to use a metronome set to beat 55 to 56 beats per minute when operating the hand machine. The crank is turned at that speed.

4. Remove the bottles and place in a perpendicular position in a rack for 10 minutes before reading the per cent of casein.

WALKER CASEIN TEST.

In determining the percentage of casein in milk by the Walker method the acidimeter containing ninth-normal sodium hydrate solution is used. In addition to the acidimeter it is necessary to have a 16.3 c.c. pipette, and a bottle of neutral formalin. The latter is prepared by adding a few drops of indicator (phenolphthalein) to the commercial formalin and adding the alkaline solution from the burette until a permanent faint pink color is obtained.

A complete explanation of the principles of the Walker Test involves considerable chemistry. It may be stated here, however, that in a protein molecule (casein is a protein) there are acid and alkaline groups and it has been observed that when formaldehyde is added to protein the neutral character disappears leaving the acid groups free to act. This is the acid measured in the second titration, and since it is proportionate to the amount of the protein present in the milk, this simple test has been made possible. It is necessary to multiply the number of c.c. of solution used in the second titration by the factor 1.63 to obtain the per cent of casein when a 10 c.c. pipette is used. Hence by using a 16.3 c.c. pipette the reading is obtained direct from the burette.

Making the Test.

Secure a representative sample of milk, mix thoroughly by pouring, then measure 16.3 c.c. and deliver into a white delf cup or beaker. Add a few drops of indicator and add the alkaline solution, as in testing for acidity, until a permanent faint pink color is obtained. Now add 2 c.c. of the neutral formalin solution, which will destroy the pink color. Fill the burette to the zero mark and again add the alkaline solution and stir until the same pink shade appears as was noted in the first operation. The number of cubic centimeters used in the second operation represents the per cent of casein in the milk.

The Acidimeter Test

PREPARATION OF REAGENTS.

A. L. GIBSON.

Acidity which develops in milk and milk products is usually due to the formation of lactic acid by the action of bacteria on lactose or milk sugar. The development of acidity in milk, cream or other dairy products depends mainly on temperature. A high temperature encourages a rapid increase in acidity whereas with a cool temperature, the production of acidity is slow. Moreover, it is found that the type of acidity produced under low temperatures is much more desirable in the manufacture of good dairy products than that produced at high temperatures. This is the reason the producer is strongly advised to cool fresh milk and cream and maintain the same at a temperature below fifty degrees Fahrenheit, until delivered to the milk distributing plant, cheese factory, or creamery.

Before the introduction of the acidimeter test, the dairyman judged acidity by the natural senses of taste, smell, and touch. Even today, the good experienced dairyman will practice the use of these senses in a very efficient manner when examining milk, cream, whey and other dairy products.

Originally the acidimeter test was designed for estimating the acidity of milk and whey during the process of making cheese. The grading of milk and cream depends largely on the amount of acidity which has developed when examined by the grader. With the introduction of compulsory cream grading, the use of the acidimeter test has greatly increased. Acidity is neutralized by alkali, and upon this principle the amount of acidity is measured in the acidimeter test by neutralizing with a standard alkali solution ,the exact strength of which is known. The standard alkali solution used in Ontario is known as ninth normal sodium hydroxide and is of such strength that when ten cubic centimetres of milk, cream or whey, are used in the test, each cubic centimetre of ninth normal sodium hydroxide required to neutralize the acidity will represent decimal one percent of acidity in the sample tested. The acidimeter test is carried out as follows:—

PROCEDURE FOR ACIDIMETER TEST.

Reagents and Apparatus required:—

1. A ninth normal solution of sodium hydroxide.
2. Phenolphthalein indicator.
3. A burette, graduated to one-tenth of a cubic centimetre. Which is used for measuring the ninth normal sodium hydroxide solution.
4. A 10 cubic centimetre pipette for measuring the sample of milk, cream, or whey.
5. A small white porcelain dish or cup, with a glass stirring rod.

NOTE:—All apparatus used for this test should be clean. Before using any measuring apparatus it should be rinsed out with a little of the solution or liquid to be measured.

Fill the burette with ninth normal sodium hydroxide solution. With a 10 c.c pipette measure 10 cubic centimetres of the sample of milk, cream, or whey to be tested into a white porcelain dish or cup. Add two to five drops of phenolphthalein indicator and titrate the alkali solution from the buurette into the sample until one drop of the alkali causes a permanent pink colour. Each cubic centimetre of the ninth normal sodium hydroxide solution used represents .1% (decimal one per cent) of lactic acid acidity. For highly accurate determinations, 10 gms. of the sample, carefully weighed, might be taken in place of measuring 10 c.c. with a pipette.

INTERPRETATION OF RESULTS OBTAINED BY THE ACIDIMETER.

Fresh milk, when tested immediately after milking, from an average herd of cows will usually give a reading of .14 to .16% by the acidimeter. This reading might be termed "Initial" or "Apparent" acidity since it is not due to lactic acid, which is not present in absolutely fresh milk, but rather to a reaction which takes place between the ninth normal sodium hydroxide and certain natural constituents of the milk. The milk from individual cows has been known to register as low as .11% and as high as .27%, "Initial" or "Apparent" acidity, but such cases are exceptional. Generally speaking, milk from a herd of cows which registers .18% or above by the acidimeter, is considered to have developed a fair degree of acidity and may be refused on this account at the factory. Where it is known that milk from a herd of cows registers a high "Initial" or "Apparent" acidity, immedately it is obtained on the farm, due allowance should be made for this when considering developed acidity at the factory. Fresh cream usually shows a lower reading by the acidimeter than the fresh milk from which it is obtained.

PREPARATION OF REAGENTS.

Ninth Normal Sodium Hydroxide Solution.—This solution should be very accurately made by one experienced in the practice of making standard solutions as used in a chemical laboratory. The provincial dairy instructor will prepare the solution on request when making his periodical visit to any dairy plant. Ninth Normal sulphuric Acid Solution which is obtained from the Dept. of Chemistry, Ontario Agricultural College, Guelph, is used as the standard in the preparation of the ninth normal sodium hydroxide solution.

The solution must be made from highest grade chemically pure sodium hydroxide sticks (alcohol purified.) Local druggists will usually stock the quality required when requested. Theoretically, a ninth normal solution contains 4.444 grams of sodium hydroxide per litre of water. Since the purest sample of sodium hydroxide stick obtainable, always contains some impurity of moisture, etc.,a slightly larger amount than this should be taken for every litre of solution required. Accordingly, weigh about 5 grams of the sodium hydroxide stick for each litre of solution to be made up. Do not let the caustic stick come in contact with the metal part of the scales or balance, but weigh the stick in a clean glass or cup. Dissolve the weighed sodium hydroxide stick in water equal to about half the volume of solution required.

Example:—For 1 litre of solution dissolve 5 grams sodium hydroxide stick in 500 c.c. water; or, for 2 litres of solution dissolve 10 grams sodium hydroxide stick in 1 litre water.

Rinse a clean burette with a little of this solution and then fill the burette to the 50 c.c. mark. With a clean pipette accurately measure 10 c.c. of the ninth normal sulphuric acid solution into a clean beaker or cup. Add two drops of phenolphthalein indicator and titrate the sodium hydroxide solution from the burette into the acid until one drop of the alkali causes a permanent pink color. Read the burette and repeat the titration until three similar readings are obtained and the exact relationship between the sodium hydroxide solution and ninth normal acid solution is established. Proceed to dilute the sodium hydroxide solution with water to exactly ninth normal strength as per the following example:—Three titrations or sodium hydroxide solution against the ninth normal acid solution gave the following results:—

10 c.c. N/9 acid solution—4.5 c.c. sodium hydroxide solution.
10 c.c. N/9 acid solution—4.55 c.c. sodium hydroxide solution.
10 cc. N/9 acid solution—4.55 c.c. sodium hydroxide solution.

Total 30 c.c. N/9 acid solution—13.50. sodium hydroxide solution.
Average 10 c.c. N/9 Acid Solution=·45 c.c. sodium hydroxide solution.

From this established relation between the two solutions it is necessary to dilute every 4.5 c.c. of sodium hydroxide solution, to 10 c.c. with water in order to make an exactly ninth normal solution, or multiplying the dilution by 100, dilute 450 c.c. sodium hydroxide solution to 1000 c.c. In other words, to every 450 c.c. of sodium hydroxide solution add 550 c.c. water. After dilution make a final titration of the sodium hydroxide solution against the ninth normal acid solution to be sure that both are equal, and correct if necessary.

NOTE:—Use a reliable burette, pipette, measuring cylinder and flask. Use distilled water **if possible.**

Phenolphthalein Indicator consists of one gram of pure phenolphthalein powder dissolved in 100 c.c. of denatured alcohol. This can be obtained from the local druggist.

Boilers, Engines, Steam Fitting

Geo. Travis.

Of all the apparatus necessary for the manufacturing of cheese and butter, the steam boiler seems to be the most essential. From it we get steam power for operating the other machinery, and steam for regulating the temperature of the milk and cream, and for other heating purposes as well; hence the selection, setting and care of the boiler, coupled with the construction of the arch and chimney so as to get the best results from the economic viewpoint, are matters of great importance to cheese and butter manufacturers.

Selecting a Boiler.—When selecting a boiler, get one of sufficient capacity to furnish all the steam required without forcing the fire under it. A boiler cannot be forced beyond its capacity without injuring it. There would also be a waste of time and fuel forcing a steam boiler.

Setting Boiler.—In setting a boiler a good substantial foundation for the arch or furnace should be provided. The arch is really a part of the boiler and unless it is properly built, good results cannot be obtained.

It is best to get a plan for building an arch from some reliable boiler maker. Then have the masonry done by an expert. Provide good fire brick for lining and have them laid with fire clay. Make the side walls of the arch thick with good common brick. This will make it more substantial and retain the heat longer, thus lessening the cost of fuel.

Chimney.—Where coal is being used for fuel, chimney should be built of brick. The area should be at least one-fifth greater than the combined area of all the flues. The height depends largely upon its location—the higher the better.

Firing the Boiler.—Boilers newly set should not have fires put under them until the mortar of the brickword has had time to harden naturally. When fire is started, heat vrey slowly and let the steam go through all the pipes before any pressure is put on them.

Care of Boiler.—Before lighting the fire in the morning, care should be taken to see that the boiler has sufficient water in it. The glass gauge in the water column cannot always be depended on at sight, therefore it is best to open the tap at the bottom of the glass to make sure that the pipes leading to, or from it, are not stopped with scale or mud. See that the safety valve is in working order. This is the most important valve in connection with the boiler. Every boiler should have a blow-off pipe at the bottom. In addition to this, it should have a surface blow-off or some "scumming" apparatus. Nearly all foreign matter held in solution in water on first becoming separated by boiling, rises to the top in the form of what is commonly called "scum", in which condition much of it may be removed by the surface blow-off. If not removed, however, the heavier particles will be attracted to each other until they have become sufficiently dense to fall to the bottom, where they will be deposited in the form of scale, covering the whole internal surface of the boiler below the water line with a more or less perfect non-conductor of heat. Where the water is very hard, some good boiler compound may be used with good results. Different waters require different treatments. For ordinary water "sal soda" is all that is necessary.

The blow-off at the bottom should be opened enough each day to let any lime or mud that might have accumulated, escape. If this is not done, there is danger of the pipe being filled with dirt, thus excluding the water from the pipe. Then there is danger of it becoming hot and bursting, causing a great deal of trouble.

If the pipe from the pump or injector which feeds the water into the boiler be attached so that the water will be fed in through the blow-off pipe, this danger will be largely overcome.

Pipe Fitting.—As there are also more or less steam pipes about the factory that need repairing, it is quite necessary that the maker should know how to do his own pipe fitting.

For ordinary work the tools required are pipe tongs. cutter. vise, and stock and dies. With these at hand any pipes or joints that may be leaking can be quickly repaired and will save the expense of sending out for a steamfitter. Steam escaping from bad joints or leaking valves makes a disagreeable noise, and money is evaporating into the air.

Engine.—The engine bed or foundation should be solid. If possible, have the engine in a room separate from the boiler, as there is always more or less ashes and dust from the furnace and flues. This makes it difficult to keep clean. Any sand or grit lodging on the slides helps to wear them out sooner than it otherwise would.

Some of the chief points to be observed are: See that it is kept clean, well oiled, and properly packed to prevent steam from leaking.

Before starting the engine, open the taps of the cylinder to let the water out, turn the fly-wheel over once, then open the throttle valve gradually until the engine gets in full motion.

Pulleys and Belting.—The following rules for finding the size of pulleys and the required length of belting will be found useful in fitting up a creamery or in placing additional machinery.

To find the diameter of a driven pulley, multiply the diameter of the driver by its number of revolutions, and divide the product by the number of revolutions the driven pulley should go. The result will be the diameter of the driven pulley.

Example.—Diameter of pulley on the engine, 40 inches; speed of engine, 160 revolutions; speed of main shaft, 200 revolutions $40 \times 160 \div 200 = 32$, which is the diameter in inches required for the driven pulley.

To find the required size of a driving pulley, multiply the diameter of the driven pulley by the number of revolutions it should make and divide the product by the revolutions of the driver.

Example.— Diameter of the pulley in intermediate is 4 inches, which is required to run 900 revolutions per minute; revolutions of shaft 200: $4 \times 900 \div 200 = 18$, which is the diameter in inches of the pulley required to drive the intermediate at proper speed.

To find the length of belt for any two pulleys, add the diameter of the two pulleys together, divide this sum by 2, and multiply the quotient by 3¼. Add the product to twice the distance between the centres of shafting, and the result will be the required length of belt.

Example.—Two pulleys are 8 and 24 inches in diameter, and 8 feet is the distance between the centres of shafting $8 + 24 = 32$, $32 \div 2 = 16$, $16 \times 3\frac{1}{4} = 52$ inches $= 4$ feet 4 inches, and 4 feet 4 inches + 16 twice the distance between the centres and the shafting) = 20 feet 4 inches, which is the length of the belt required.

Rules.—To find the circumference of a circle multiply the diameter by 3.1416. To find the diameter of a circle, multiply the circumference by .31831. To find the area of a circle multiply square of diameter by .7854. Doubling the diameter of a pipe increases its capacity four times.

Separators and the Separation of Milk

C. E. Lackner.

Factory or power separators may be divided into three classes—the steam or turbine, the belt machine and the electric driven. A book of directions is furnished with each new separator; therefore, general directions only can be given.

TURBINE SEPARATOR

When setting up the separator, a solid foundation should be provided. It does not matter how solid a wooden floor is, it will vibrate more or less from the running of a churn or other machinery. With a stone, brick or cement foundation a separator is independent of any vibration from other machinery and will run much better, and for a longer time. If setting the separator on a cement floor probably the most permanent method of fastening it down is as follows: First mark the exact location for the holes. With a square, draw a line through the centre where the holes should be, then drill the cement to the desired depth (6 or 7 inches). To do this a common cold-chisel may be used providing the bit is wide enough for the body of the chisel, though a pointed chisel for this purpose is preferable. The dust may be removed from the hole while drilling by a small bellows, or blowing through a small rubber or glass tube. Have the bolt head somewhat rounded and place the bolt in the hole with the threaded end up, making sure to have it perpendicular and in line, and the necessary height above the floor, then pour melted lead in the hole around the bolt. If a method is desired whereby the bolts can be removed from the floor, drill holes as above, plug with wood, bore with a bit at least one-eighth of an inch smaller than the lag screws used and fasten down with lag screws. Another method whereby separators may be changed without drilling new holes is to drill the holes in the cement nearer to the centre than any separator will be likely to require, fasten a 2-inch by 4-inch piece of wood to the floor and bolt the separator to it.

In putting down a cement floor to be used for separators, it is well to have a pier built about two inches higher than the floor and about the size of the separator base. This tends to prevent dirt from lodging under the separator when scrubbing the floor.

If a pier has to be built, the nature of the soil will determine the depth to excavate, and the size of the frame or base of the separator will determine the length and breadth. The exact specifications are given in the book of instructions furnished with the separator.

Place the separator in position, being careful to have the separator frame perfectly level every way. Determine this by placing the spirit level upon the planed top to the frame.

The pipe to convey the steam to the separator may be the same size as the fittings of the separator, provided the distance from the boiler is not over twenty-five feet. When the distance is more than this, the size of the pipe should be one-quarter inch larger for every twenty-five feet of piping, to overcome the effects of friction and condensation of steam.

Exhaust pipes are usually made of galvanized iron, and should never be reduced in size at any point smaller than the outlet on the separator, and should be put up as straight as possible to convey the steam from the separator. It may be carried out at the side of the building. In either case, a piece extending upwards should be put up to cause a draught. Placing the exhaust pipe out through the roof is preferable when the surroundings will permit it. Have the pipe long enough to be higher than any part of the roof, in order that the draught may not be interfered with by change of wind. A drain pipe must be provided in any case at the lowest point on the pipe, to allow water to escape readily. If this should be in the making-room, a trap to prevent annoyance from escaping steam may be put on the drain pipe.

BELT SEPARATOR.

The directions given for the foundation of a turbine will apply to this. First, place the separator in position. This should be at an angle of at least 45 degrees in front of or behind the driving shaft. The pulley provided for the driving shaft should be of sufficient width to allow the belt to be shifted from the tight to the lose pulley of the separator and of the proper size to give the exact speed required. Line the separator pulley with the pulley on the driving shaft. Level the separator in all directions by placing the level on the planed top of the frame. The separator bowl should revolve to the right, or with the sun, the same as the hands on a watch.

Wipe all the bearings well with a cloth, to remove all grit and dust. A little coal oil upon a cloth will be found helpful where any coating of dried oil is met with. See that all oil tubes are clear and free to feed oil. Wash the bowl and all parts that the milk comes in contact with. If everything has been properly attended to as directed it is ready to start. If a turbine, turn on steam very gradually to allow the water to get out of the steam pipes, when the required amount of steam may be turned on. When speed has been reached, start the feed of milk.

If a belt machine, start the engine at full speed, then shift the belt from the loose pulley part way on to the tight pulley, moving it at intervals until on full. From 6 to 10 minutes should be required to get up speed. Full speed is ascertained by means of speed indicators. A 100-notch wheel should be counted for one minute, and a 50-notch wheel for one-half minute, in order to know the number of hundred revolutions the bowl is revolving per minute. After speed has been reached, the milk should be turned on full speed, until both cream and skimmilk flow from the respective spouts; then it should be closed off until the cream is of the desired thickness. The cream should be the guide in operating the separator.

The cream left in the bowl when all the whole milk has been put through should be forced out with warm water. From one to two pails will be needed for this purpose. Shut off the feed-tap for a few seconds when about half the quantity has gone through; then turn it on again, allowing the remainder to complete the operation. Pure warm water is preferable to skim milk, as it is nearer the specific gravity of the cream, and consequently displaces it more readily.

Allow the bowl to stop of its own accord after the power has been removed. Remove the solid matter found at the extreme outside of the bowl and burn it at once. Clean out all milk tubes with the spiral provided; wash with tepid water thoroughly; scald with steam or boiling water; then place on a draining rack where the bowl and its parts may dry. Never close the bowl when wet inside, as it will cause it to rust. Leave it open when not in use so it will be thoroughly dry.

In ordering the parts of the separator always specify exactly what is wanted by the use of the proper name and number of the same. This can be found by consulting the book of instructions furnished with all machines. A duplicate set of the delicate or wearing parts of any machine should be kept on hand for emergencies.

Milk fresh and warm from the cow is in the best possible condition for a perfect separation. The difference in specific gravity between the fat and other portions of the milk is then greatest, and it is also more fluid, as there is no development of lactic acid, nor chemical changes due to its exposure to the air. At the creamery, it is not met with in this favorable condition; consequently it is necessary to produce artificially as many of the favorable conditions as possible to get the best results. When milk is received at a temperature below 85 deg. it should be heated to from 90 deg. to 100 deg.

A tempering vat should be elevated at a suitable height to allow the milk to flow into the separator; and it should contain enough milk to employ the separator for at least four minutes. If large bodies of milk are heated to the desired temperature in a vat before separating, acid develops too rapidly and clogging of the separator bowl is likely to follow. Should any accident happen whereby the separator is stopped, the milk would likely develop acid enough to thicken, when it could not be separated.

ELECTRIC DRIVEN SEPARATOR.

The general instructions for setting up this type of separator are similar to those given for the turbine. This separator is driven by an electric motor, which is part of the separator, and is attached to the frame. When setting up the separator, it is necessary to have it in as dry a place as possible, as dampness is injurious to the motor. The motors are made as nearly water tight as they can be, but care must be taken to keep the water away from them, so as not to injure the motor.

The drive pulley of the motor is connected to the driven pulley of the separator by means of a short endless belt. When starting the separator, it is necessary to have the belt loose enough to allow it to slip, thus allowing the separator bowl to start gradually. By means of a belt tightener, the belt can be tightened at intervals as the separator gains speed, until full speed is attained. An endless belt must be used as a laced or joined belt causes the separator to vibrate, which results in inefficient skimming. Some of the motor-driven separators are equipped with a clutch pulley, which does away with all need of attention in bringing the separator up to speed, slipping while starting occurs within the pulley itself, thus reducing wear on the belt while at the same time protecting the motors and separator gearing. When the separator is not equipped with this type of clutch pulley, always be sure the belt is loose when starting to prevent injury to the motor and separator.

HAND CREAM SEPARATORS.

At present there seems to be an unlimited market for sweet cream of good quality. Since cream is a perishable product, that cannot retain its good flavor for any definite length of time, it is necessary to adopt methods for creaming, most favorable for the production of the desired article.

Where milk is properly cared for at the farm, good cream can be produced for buttermaking by means of the shallow pans or deep setting system, but on account of the length of time required to produce cream by this method it is not practicable for the sweet cream trade.

The best known method for creaming at the farm is the hand centrifuge more commonly known as the cream separator.

Some of the advantages of the cream separator over the old style gravity systems are:

The milk may be put through the separator immediately after it has been drawn from the cow, at which stage conditions for efficient creaming are most favorable, and the skim milk is then in the best condition for feeding purposes.

The richness of the cream may be regulated to the desired consistency by adjusting the cream screw. By this means it is possible to extract more of the milk serum from the cream, thus reducing the quantity to be cared for.

There are many other advantages which might be enumerated, such as: Less ice needed for cooling, fewer utensils to be washed, etc.

The chief objections to the hand separator are: the initial cost and the labor involved in turning and washing the machine, but when it is taken into consideration that the increased product made from the saving in loss of fat in the skim milk over the best of other methods of creaming, these objections may be overlooked.

In choosing a separator it is advisable to select one with sufficient capacity for the amount of milk produced; one which is simple in construction, strong and durable with reasonable care, and one having all parts, which come in contact with the milk, easily washed. The manufacturers should guarantee that the machine will do good work, or no pay.

There are many different makes of separators on the market, but which is the best, it is impossible to say, as no one separator possesses all the points of merit that the ideal might possess. The best separator might be described as that best suited to the special conditions under which it is to be used. For example, the closest skimming separator may be more difficult to operate, or possess other disadvantages in its construction less desirable than a machine which skims less closely, and these disadvantages may more than counterbalance its closer skimming qualities. It would be a very poor separator indeed that did not have some good points, and it would be the ideal if it did not have some weak points. A hand separator may be considered as doing good work when, running at its full capacity, it will produce a cream testing from 30 to 40 per cent. fat, and not leave more than .05 per cent. fat in the skim milk. To a certain extent the reputation of a separator as to its efficiency for creaming milk will depend upon the one who operates it.

With each separator is sent a book containing full directions for setting up and operating the machine. These instructions should be strictly followed unless you know something better, which you have proven to be so by practice.

Select a suitable place in which to locate the machine, where a pure atmosphere can at all times be assured. A well-built milk room in the barn that can be kept free from dust and stable odors, easily kept clean and tidy, may be most convenient, but it is advisable to have a separate milk house built in such a manner that it will be easily kept in a sanitary condition, with good ventilation and plenty of sunlight, not too far from where the cows are milked so that the milk does not require to be carried a great distance.

The foundation on which the machine is to be fastened must be solid, and the part of the frame which carries the bowl must be level every way. Before putting the different parts of the machine together each part should be thoroughly cleaned by using a cloth made damp with kerosene or gasoline.

After the machine has been properly put together, before starting, see that the oil cups are properly delivering the oil to each bearing. If at any time the bearings appear to be gummed, a little coal oil may be used with good results.

The number of revolutions required to give the proper speed is usually tabulated on the crank of the machine. Two or three minutes should be taken to get up full speed. The supply tank or feed can should contain sufficient water, at a temperature of 110 degrees, to fill the bowl. This should be put through the machine first to warm the skimming device and prevent the milk from sticking. The milk then should be turned on full flow, and the supply can kept well filled until the milk is all in. The speed should be kept as uniform as possible. If the separator is to yield cream of uniform richness, it must be given the same speed at each time of using.

It is almost impossible to obtain cream of uniform richness with a cream separator, unless care is taken to operate it the same at all times. There are numerous reasons for lack of uniformity in the richness of the cream and excessive losses of fat in the skimmilk, which can be avoided by careful operation.

The speed of the separator should be uniform at all times. When a separator is turned below normal speed it causes a lower testing cream and a larger loss of fat in the skimmilk, due to the fact that low speed reduces the centrifugal force, the force that causes separation, and this reduction in force prevents the milk from being so completely separated as when sufficient force is applied. Thus we have more fat passing out in the skimmilk and a lower testing cream High speed brings about a more complete separation causing a higher testing cream than when operating at normal speed.

The rate at which the milk enters the bowl will affect the test. The float does not fully regulate and assure a constant flow of milk into the bowl. The flow of milk is controlled partly by the tap and the amount of milk in the supply tank. If the milk enters the bowl faster than it should it causes a lower test and high loss of fat in the skimmilk, due to the fact that the milk is forced through the bowl before it is properly or completely separated. If the faucet in the supply tank is only partly open, or if the supply tank is allowed to empty two or three times during separation it will cause an increase in the test of the cream.

The temperature of the milk has an effect on the cream test and loss of fat in the skimmilk. The best practicable temperature at which to separate the milk on the farm is from 90 deg. to 100 deg. F. Milk is never in better condition for separation than immediately after it has been drawn from the cow. If the milk be allowed to cool, as is sometimes the case in winter, when the separator is only used once a day, it should be warmed to at least 90 deg. F. before it is separated, otherwise, there will be an increase in the cream test as well as an increased loss of fat in the skimmilk. This is due to the fact that the cold milk is thicker and more viscous. The cream being thicker does not run from the cream outlet so quickly. This slow movement partly blocks the cream outlet, decreasing the capacity of the outlet, causing more skimmilk to be taken from the cream, thereby increasing the test of the cream. The cold milk being more viscous, or sticky, prevents the separation from being so complete as it should be, thereby causing a large loss of fat in the skimmilk.

Flush water or skimmilk is generally used after separating to force out any cream which is sticking to the bowl. The amount used will cause the cream test to vary. The reason for this is quite apparent. The flush water goes into the cream, and the more water used the lower the cream test will be. It is practically impossible to cut the flow off at the cream spout the same time at each separation.

The per cent of fat in the milk has an effect on the cream test. The test of the cream varies directly with the test of the milk separated. A cream separator is so constructed that it cannot be adjusted to produce cream with a constant and definite test, but takes a definite amount out of the milk separated as cream regardless of the per cent of fat in the milk. That is, if 100 lbs. of 3% milk be separated, and 100 lbs. of 5% milk be separated with the same separator, the pounds of cream would be practically the same in both cases. The cream from the 5% milk would test much higher than that from the 3% milk. Milk from a herd will vary in test depending on various conditions, and as the milk test varies so will the cream test vary.

Dirty milk, old milk, or sour milk, also causes a variation in the cream test and a large loss of fat in the skimmilk. Sour milk clogs the separator, blocks the skimmilk and cream outlets, causing loss of fat in skimmilk and a variation in the cream test. Dirty milk is also likely to clog the cream or skimmilk outlet with the same effect as sour milk.

A cream separator that is not set level and on a solid foundation, causes the bowl to vibrate or tremble. The tremble or vibration of the bowl will cause a re-mixing of the cream and skimmilk in the bowl, which causes a variation in the cream test as well as a large loss of fat in the skimmilk.

Creaming milk with a dirty separator bowl causes test variation. The dirt which accumulates in the bowl of the separator is very sticky and retards the free movement of the milk through the bowl, causing a change in the fat content of the cream. Sometimes small pieces of dirt become lodged in the cream or skimmilk outlet partly or completely blocking the flow. This condition is bound to cause a test variation, or large loss of fat in the skimmilk.

The practice of leaving the Separator unwashed from time to time after using cannot be too strongly condemned. Only a clean separator can deliver cream that is pure, sweet, and of desirable flavor; hence, it is very important that all moveable parts of the bowl should be taken apart and thoroughly cleaned after each separation. All remnants of milk, cream and slime should be washed off with warm water, after which they should be washed in hot water, containing a good washing powder, then all parts should be thoroughly scalded and left exposed to sunlight, if possible, until again required.

After each separation, the can containing the cream should be set in cold water, and the cream cooled immediately to a temperature as low as possible. The cream should remain in the cool condition until it leaves the farm. This will prevent souring in the summer and freezing in the winter.

When different lots of cream are to be mixed, the fresh cream should always be thoroughly cooled before it is put with the old cream. Adding fresh, warm cream to cream that has been separated and held for some time causes the development of lactic acid, which if not properly controlled, will cause undesirable flavors in the cream and butter.

Never allow the cream to be placed where it will come in contact with objectionable odors, such as stable odors, vegetables, musty cellars, gasoline engines, etc., as cream will absorb these odors very readily, causing cream and butter of undesirable flavor.

Creamery Buttermaking

D. MacMillan.

Ontario cream grading regulations require that all cream manufactured into creamery butter shall be purchased on a graded basis.

The present standards for grades are:

Special Grade:—This grade shall include any lot of cream which is clean in flavor, of uniform consistency, and suitable for making butter of this grade. Its acidity shall not be more than .30 of one per cent at the time of grading at the creamery where it is to be made into butter and the fat content shall be not less than 28 per cent.

First Grade:—This grade shall include any lot of cream, which is reasonably clean in flavor, of uniform consistency, and suitable for making butter of this grade. Its acidity shall be not more than .60 of one per cent at the time of grading at the creamery where it is to be made into butter.

Second Grade:—This grade shall include cream that does not meet with the requirements specified for first grade cream, such as cream that is "bitter", "stale", "metallic", or otherwise unclean in flavor, or has an acidity of over .60 of one per cent. **Off Grade:**—This grade shall include any cream with a strong, objectionable odor, or flavor, such as gasoline, leaks, stable, or such other flavor that may render cream unfit for making second grade butter.

Immediately on arrival at the creamery the cream should be carefully weighed, sampled, and properly graded, and the several grades should be pasteurized and churned separately.

PARTIAL NEUTRALIZATION OF CREAM FOR BUTTERMAKING.

Sour cream is not desirable in the manufacture of high quality creamery butter because of the detrimental effect of high acid cream on the keeping quality. This fact is now generally known. Much of the butter produced in our creameries to-day is manufactured from cream in which the acid has been reduced by the addition of some form of neutralizer.

Some of the advantages gained from neutralizing sour cream are as follows:—

It prevents excess fat losses in the buttermilk. It avoids sour flavors in the butter and when combined with proper pasteurization it improves the keeping quality of the butter, whereas the pasteurization of sour cream without neutralization is of doubtful benefit.

The point to which the various high acids should be reduced is as yet an undecided question and must, to a large extent, be determined by the individual buttermaker, based on his local conditions. We may, however, by proper neutralization methods, reduce the acid in sour cream from .60 to .20 per cent without imparting a neutralized flavor to the butter. Several neutralizing agents are used for reducing the acid content of cream. Of these, perhaps those in most general use are Magnesia Lime, Hydrated Lime, and "C. A. S." A convenient method of preparing these alkalis for use, is to mix magnesia lime at the rate of one and one-quarter pounds of lime to eight pounds of water. One pound of this solution will neutralize one-half pound of acid. Mix hydrated lime at the rate of one pound of lime to four pounds of water. One pound of this solution will also neutralize one-half pound of acid.

Example.—Having 1868 pounds of cream in a vat containing .52 per cent acid and it is desired to reduce the acid to .22 per cent.
.52—.22=.30—$\frac{1868\times.30}{100}$=.56 pounds of acid to be neutralized.

One pound of either of the above solutions will neutralize one-half pound and two pounds will be needed for one pound of acid. Therefore, 5.6×2=11.2 pounds of solution are required to reduce the acid in this vat of cream from .52 to .22 per cent. Lime solutions may be prepared in quantities sufficient for several days use, and kept in covered containers. Care must be taken to see that the solution is thoroughly mixed before the amount required is removed from the container, then dilute with equal parts of water before adding to the cream. Hydrated lime is not always of uniform strength, and the strength of different lots must, therefore, be determined individually.
.75 lbs. of "C. A. S." will neutralize one pound of acid in cream .

Example:—1572 pounds of cream contain .54 per cent of acid, and it is desired to reduce the acid to .22 per cent. .54—.22=.32 to be reduced. $\frac{1572\times.32}{100}$—5.03 pounds of acid to be neutralized.
.75 pounds of "C. A. S." will neutralize one pound of acid, therefore, 503×.75=3.77 pounds of "C. A. S." powder are required to reduce the acid in this vat of cream from .54 to .22 per cent.

Other neutralizing agents are, Sodium Bicarbonate, (Baking Soda) and "Wyandotte Special". One pound of soda will neutralize approximately one pound of acid. **Example:—2260** pounds of cream contain .56 per cent acid, and we wish to reduce the acid to .25 per cent.
.56—.25=.31. $\frac{2260\times.31}{100}$=7.0 pounds of acid to be neutralized.

As one pound of soda will neutralize one pound of acid, it will, therefore, require seven pounds of soda to reduce the acid in this vat of cream from .56 per cent. to .25 per cent. One pound of "Wyandotte Special", will neutralize two pounds of acid. **Example:**—1852 pounds of cream contain .52 per cent acid, and we wish to reduce the acid to .25 per cent: .52—.25=.27. $\frac{1852\times.27}{100}$=5.0 pounds of acid to be neutralized. One pound of "Wyandotte Special" will neutralize two pounds of acid. It will, therefore, require two-and-one-half pounds of "Wyandotte Special" to reduce the acid in this vat of cream from .52 to .25 per cent.

In the preparation of Soda, "C. A. S.", or "Wyandotte Special" solutions, add six to eight pounds of warm water to each pound of Soda, "C. A. S." or "Wyandotte Special". Never use cold or boiling water, They are readily soluble in warm water, and should be prepared in quantities sufficient to meet the requirements for each vat immediately before the addition of them to the cream. The temperature at which the neutralizer is added to the cream will depend somewhat on the condition of the cream and the kind of neutralizer used. Under normal conditions, with cream containing around 30 per cent fat and not more than .5 per cent. of acid, the temperature should be 80 deg. F. At this temperature, the cream should be tested for acid and the required amount of neutralizer ascertained and added to the cream by spraying slowly from end to end of the vat with the coil in motion. An ordinary sprinkling can is suitable for this purpose.

No buttermaker should attempt to neutralize the acid in cream without first having proper equipment for ascertaining the exact amount of acid in the sour cream. He should make sure that the alkaline solution and Phenol. indicator used are of the proper strength, and thoroughly understand the nature of the neutralizer which he is about to use. He should also understand that a sweet or a sour cream may be pasteurized without difficulty, but if cream which is just turning sour, that is, cream containing around .30 per cent of acid, be subjected to certain temperatures it is likely to curdle. The temperature at which this curdling is most likely to take place while heating the cream is from 110 to 130 degrees during pasteurization. A lime neutralizer, will, when added to cream at a temperature of 80 deg. F. and the heating continued, require ten minutes to do most of its work. From this point on the reduction in acid will be small,—about .05 per cent. and the action slow. Therefore, avoid having the acid around .3 per cent., while raising the temperature from 100 to 135 degrees, or serious trouble may result, especially if the cream be low in fat and high in acid. In fact, it is a dangerous practice to add the full amount of a slow acting neutralizer such as lime to a cream to this nature at a temperature of 80 degrees and then proceed with the heating in the usual way. This method will almost be sure to cause the formation of a soft fluffy curd in the cream, some of which will be incorporated in the butter when working, and although it cannot be detected when the butter is fresh, the prints will, within a very few days, develop a sort of Limberger Cheese flavor which renders them wholly unfit for table use, causing serious loss. A number of creamery men have already experienced this trouble.

There are, however, methods by which a thin, high-acid cream may be successfully neutralized with a lime neutralizer. Heat the cream in the usual way to a temperature of 90 degrees. At this temperature add one-half the required amount of neutralizer. Continue the heating and at a temperature of 110 degrees add the remainder. Then complete the heating as quickly as possible. This method will hold the acid sufficiently high until a temperature of 135 degrees is reached when all danger of curdling will be past.

Another, and perhaps safer, method is to use one of the quick-acting neutralizers. Sodium bicarbonate or "Wyandotte Special" may be used in the regular way and will eliminate the danger of curdling. One objection to the use of Sodium Bicarbonate is that it will cause a high acid cream to foam badly. "Wyandotte Special" will not cause this foaming and for that reason preferred by some where it is found necessary to use a quick-acting neutralizer.

It is very doubtful if there is any one neutralizer which is suitable for neutralizing all the excess acid in very sour cream, and some buttermakers follow the practice of reducing part of the acid with lime and part with soda. Where this method is followed, use the lime first and finish with the soda.

Cream containing about .30 per cent acid cannot be successfully pasteurized by the flash method. Where this method is preferred, the cream must enter the pasteurizer with an acidity above .35 per cent or be reduced to .28 per cent, or below. The required amount of cream for one churning should be placed in a vat or forewarmer. Heat to a temperature of 90 degrees and add the necessary amount of neutralizer. When the acid has reached the desired point, proceed with the pasteurization.

PASTEURIZATION

As soon as the grading is completed, the cream should be pasteurized, and, if necessary, neutralized. The chief object in pasteurization is to destroy most of the bacteria present in the cream. In this way it is possible to secure a more uniform quality of butter.

There are two methods of pasteurization in use—the "flash", or "continuous", and the "holding", or "vat". By the **flash** method, the cream is heated while passing through the pasteurizer, to a temperature of 180 deg. F.. It is then passed over a cooler and quickly cooled to churning temperature.

At the present time the "vat" method has almost entirely replaced the "flash" method of pasteurizing cream for buttermaking.

By the "vat" method the cream is put into a vat pasteurizer and heated to a definite temperature. Various temperatures and various lengths of time for holding are in use. The temperature recommended is 170 - 180 deg. F., and that this temperature shall be maintained for a period of 15 to 20 minutes.

As the efficiency of pasteurization is dependent largely on temperature, it is important that the proper temperature be used, and with the vat method, that it be maintained for the full holding period. The cream should then be cooled as quickly as possible to churning temperature, and be held at this temperature for several hours before churning. It is a well known fact that the butter fat in cream requires several hours of thorough chilling prior to churning, if good body and grain are to be obtained. It is also a fact that butter made from cream churned immediately after cooling, will be much softer in body than similar butter would have been had the cream remained cold for several hours prior to churning.

Under conditions where cream is received in the afternoon, the usual practice is to pasteurize, hold for 10 - 15 minutes, then cool to churning temperature, and hold the cream at this temperature until next morning.

CREAMERY CHURNING.

Churning is the process of separating the butter fat from the other constituents in cream. The time required to complete this process is affected by many factors, chief of which are:—the percentage of fat in the cream, the temperature of the cream, the speed of the churn, the amount of cream in the churn, the nature of the agitation, and the size and nature of fat globules. The fat globules exist in cream in large numbers, and the richer the cream, the more closely they will come into contact with each other. For this reason, rich or high-testing cream, will churn more easily than poor cream. A cream containing 30 to 35 per cent. fat is the most satisfactory for churning. A cream much richer than this will adhere to the sides of the churn, which reduces the amount of concussion. The addition of water to the cream will overcome this, and cause the butter to come in a reasonable length of time. It is better, however, to avoid an excessive richness in the cream.

The temperature of the cream is an important factor in determining its churnability. Other conditions being equal, the higher the temperature, the more quickly the churning process will be completed. However, it should always be well below the melting point of the butter fat. If the temperature be too high, there will be a large loss of fat in the buttermilk, the butter will have a greasy texture and cannot be worked properly, and too much buttermilk may be incorporated into the butter. On the other hand, if the temperature be too low, the churning process will be very difficult to accomplish, the butter granules will be too small, and there will also be a loss of time and power. Churning temperature is of great importance, and will vary considerably under different conditions. The proper temperature to use must be determined by the Buttermaker, based on his knowledge of local conditions. Under normal conditions the proper churning temperature will vary between 42 deg. F. and 52 deg. F.

The speed at which a churn is revolved has a marked effect on the time required for churning, and varies with the construction of the churn. It should, however, be such as to give the greatest degree of agitation to the contents of the churn. Should it be too rapid, the force will hold the cream against the inner surface of the churn and it will receive very little agitation.

If the speed be too slow, the cream will not be carried up the sides of the churn from which it falls, before reaching the top. The speed suggested is from 22 to 25 revolutions per minute for the "Success" type of churn, and 35 to 38 revolutions per minute for the De Laval type.

The ease with which cream may be churned is affected by both the size and quality of the fat globules. The character of the fat is influenced by the breed of the cows, the period of lactation, and the feed given to the cows.

If too small an amount of cream be churned it may adhere to the sides of the churn, and receive little or no agitation. On the other hand, if the churn be too full, there will be little opportunity for the cream to fall, hence, little agitation, and a large loss of fat in the buttermilk. Overloading the churn. and too slow a speed, should be avoided at all times. Best results will be obtained if the churn be from one-third to one-half full of cream. With this volume, other conditions being correct, the churning process should be completed in approximately forty-five minutes.

Churning Operations.—Before adding the cream, the churn should be scalded, and thoroughly cooled with cold water. This will freshen the churn and fill the pores of the wood so that the butter will not stick to the inside of the churn.

All the cream should be carefully strained into the churn, as this removes the particles of curd which, if allowed to enter the churn, will cause specks to appear in the butter.

Adding Color.—If color is necessary, it should be added to the cream before starting the churn. The amount of color to add will depend on the natural color of the cream, and the market demands.

Starting the Churn.—Before starting the churn care should be taken to see that all vents are closed, and during the first five minutes of churning, the churn should be stopped several times and the vents opened to relieve the air and gas pressure developed inside.

When to Stop the Churn.—When butter granules appear in the buttermilk, and are about the size of small peas, the churning process is completed. The two things aimed at are, the completeness of the churning and the removal of the buttermilk. If the granules are too large, buttermilk will be incorporated in them and cannot be washed out. As soon as the churning has been completed, the buttermilk should be drawn off through a fine strainer to prevent the loss of small particles of butter.

The purpose of washing the butter is to remove the buttermilk, and under some conditions, modify the hardness or softness of the butterfat. The amount of washing which the butter should receive will depend on the quality of the cream. Having cream of good quality, spraying and one washing will be sufficient, but with cream of poor quality the butter should be washed twice. Nothing but pure water should be used. The amount of water should be equal, ordinarily, to the amount of cream in the churn. In the case of overchurned butter, add a large amount of water. The churn should then be revolved a few times at churning speed (eight to ten revolutions are sufficient). Under normal conditions the temperature of the wash-water should be similar to that of the cream, but if the room temperature is high, and the butter is soft, water several degrees lower than the temperature of the butter should be added and this allowed to stand until the butter is cooled to the temperature of the water. If the butter is too hard, it can be softened by adding water a few degrees warmer than the temperature of the butter.

Salting the Butter.—The rate at which the butter should be salted depends on the requirements of the markets, and may vary from nothing to three per cent. in the finished butter. It is well to remember, however, that for general trade a mild-salted butter is usually preferred. Nothing but the best grade of dairy salt should be used. It should be sifted through a fine sieve, and if very dry, it should be moistened before applying it to the butter.

Just here it might be well to point out that during the past few years there have been a number of complaints regarding "mottles," or in other words, large waves of different colors appearing in the butter after it is held in storage for a short time. This is caused by uneven distribution of the salt, and in order to avoid this defect, great care should be taken when adding the salt.

With a "Success" or "Simplex" type of churn, apply evenly over the surface of the butter while in the granular form about half the amount of the salt. Give the churn one-half revolution, which will turn the butter over, apply the remainder of the salt, and give the churn a few revolutions before adjusting the worker. With the "Alpha" or "Victor" type of churn, apply evenly over the surface of the butter while in the granular form about one-third of the amount of salt, give the churn one revolution with the rolls stationary, which will turn the butter over. Apply one-half the remaining salt, and give the churn another revolution with the rolls stationary. Apply the remainder of the salt,while the butter is in this loose condition and before adjusting the rolls give the churn one or two revolutions. This will allow the salt to work in and insure an even distribution.

Working the Butter.—The main defects in the finished butter, are: mottles, too much free moisture, and poor finish, all of which are under the control of the Buttermaker, and should receive close attention.

The objects of working butter are to evenly incorporate the salt, to thoroughly incorporate the moisture, and to give the butter a close texture.

The butter should be worked enough to give it a firm, even body, and to prevent the appearance of mottles, or free moisture, after it is printed or packed. Just how much time this will require the individual Buttermaker must determine for himself, for the reason that there are a number of conditions which cause a variation in the length of time required to work the butter properly.

These conditions are:—

(1) The amount of butter in the churn.

(2) The speed and type of the churn.

(3) The size of the granules.

(4) The temperature of the butter.

When there is a fairly large amount of butter in the churn, fewer revolutions will be required than with a small amount, for the reason that the small amount of butter will receive little or no pressure, while passing through the rolls, and it will be difficult to distribute the salt evenly. On the other hand, if the capacity of the churn be overtaxed, satisfactory working cannot be obtained.

There is considerable variation in the speed of the different types of churns, and this will have a marked effect on the time required to work the butter. If the butter be overchurned, or passed through the rolls before adding salt, it will be more difficult to distribute the salt evenly through the butter. A number of tests for salt in Creameries, where the trench method of salting was used, showed considerable variation, in the per cent of salt, in samples of butter taken from different places in the churn. The following figures represent the highest and lowest per cent of salt found in two churnings of finished butter:

Churning No. 1,	1.3 and 3.1 per cent.
Churning No. 2,	1.6 and 4.3 per cent.

This unevenness in salt content will almost assuredly cause mottled butter.

If the butter be too soft, it will receive little or no pressure while passing through the rolls, resulting in poor body and too much free moisture. It is, therefore, important that the butter have sufficient firmness to stand the pressure required to work it properly.

The Buttermaker should aim to drain the churn sufficiently before adding the salt, to have just enough water left in the churn to supply the butter with the proper amount of moisture well incorporated when the working is complete.

If, however, there be too much water left in the churn when starting to work the butter, it must be removed before the working is finished, otherwise, it will appear as free moisture in the butter.

While it is important that the butter should be worked sufficiently to give it a smooth, firm body, and to thoroughly incorporate the salt and moisture, it is also well to remember that overworking will break down the body and give a greasy texture.

Packing and Printing.—Butter is usually in the best condition for packing immediately after it has been worked. The form in which the butter is finished will depend on the market demands. When made for immediate use, the one-pound print is usually preferred; but if it is intended for export, or to be put into cold storage, the 56-pound box is required.

There are two methods in common use for making one-pound prints —the hand printer and the printing machine. Where the hand printer is used, the butter should be handled at such a temperature as not to affect its body, the prints should have square corners, be free from holes or finger marks, and be neatly wrapped in good quality parchment paper. They should weigh 16¼ ounces (with wet wrapper) to allow for shrinkage. When filling 90-pound boxes for the printing machine, care should be taken to have the butter well packed into the box and when about half full, press the butter spade down between the butter and the inner surface of the box until it reaches the bottom; repeat this operation when the box is nearly full. This will lessen the danger of air holes and give the butter a smoother surface when pressed out of box.

If the butter be put into 56-pound boxes, the box should be new, well paraffined on the inside, and lined with good parchment paper. The parchment paper should be soaked for at least 24 hours before using, in a strong brine solution, containing a small amount of formalin, to prevent mould. After lining the box, and before adding the butter, each box should be weighed and the weight marked on the side of the box. The butter should be carefully packed into the box and the top neatly finished. A 56-pound box should contain from one-half to one pound butter extra, to allow for shrinkage. The date and the number of the churning should be placed on the side of each box.

Storing and Shipping.—As soon as the butter is printed or packed it should be put into the refrigerator. The refrigerator should be kept clean and tidy, and be whitewashed frequently to keep it fresh and sweet. It should be kept at as low a temperature as possible. Where the ice is stored above the refrigerator, the ice chamber should be kept well filled with ice. If round cylinders are used for cooling, they also should be kept well filled with ice. The addition of salt to these will help reduce the temperature. It is well to remember that butter is a perishable article, and unless stored in a temperature below freezing the quality will deteriorate very rapidly.

When shipping, see that the boxes are handled carefully, kept clean, and protected from the sun while in transit to the refrigerator car.

Care of Churns, Cream Vats and Other Utensils.—After the butter has been removed, the churns should be washed first with moderately hot water, then twice with boiling water, after which allow plenty of pure air to circulate through the churn, as this will dry the inside and prevent musty odors. Once a week the churn should be given a wash with lime water, to keep it fresh and sweet, or, the churn may be treated with an acid bath, which is prepared as follows: for each pail of boiling water put into the churn, add one ounce of sulphuric acid, and revolve the churn on high speed for at least fifteen minutes. The volume of water to use will depend on the size of the churn, but ten to fifteen pails should be sufficient.

The sulphuric acid should first be mixed with a small amount of cold water, and this mixture added to the churn after the water. Do not at any time attempt to add sulphuric acid to boiling water, as this is a very dangerous practice. The gear and outside of the churn should receive careful attention and be kept clean and tidy.

Cream vats, pasteurizers, and other creamery utensils, should be first rinsed with warm water, then washed with hot water and a brush. (A small amount of good washing compound may be added to the wash water.) Then thoroughly scald with boiling water. Boiling water and human labor are both expensive, yet both are essential for cleanliness.

GRADES FOR CREAMERY BUTTER.

Scale of Points for Scoring Butter.

Flavor 45, Texture 15, Incorporation of moisture 10, Colour 10, Salting 10, Packing 10, Total 100 points.

Special Grade Butter.—Must be made from properly pasteurized cream, showing no reaction by "Storch Test." Total score, 94 - 100; min. score for flavor, 41.

First Grade.—Total score, 92 and under 94; min. for flavor, 39.

Second Grade.—Total score, 87, and under 92; min. for flavor, 37.

Third Grade.—Total score, under 87; score for flavor under 37, unless "no grade."

No Grade.—No score given—butter inferior to third grade.

Factory Cheddar Cheese Making

T. J. McKinney.

It is very desirable that throughout the Dominion there be standards for dairy products. Since April 1st, 1923, all creamery butter and factory cheese of Canadian origin intended for export, must be graded before being exported.

GRADES FOR CHEESE.

Special Grade.—Score 94 to 100 points. Minimum for flavor, 41 points.

First Grade.—Score 92 and under 94 points. Minimum for flavor, 39 points.

Second Grade.—Score 87 and under 92 points. Minimum for flavor 37 points.

Third Grade.—Score under 87 points and under 37 points for flavor.

No Grade.—Cheese inferior in quality to Third Grade.—No score given.

Something that will help a cheese-maker to detect the weak places in his methods of work, thus enabling him to correct cheese defects and make a much better grade of cheese, is to keep an accurate and detailed daily record of his work.

Before boxing the cheese for shipment, the cheese-maker should take his daily record, go to the curing-room and score a cheese out of each vat. When he finds an exceptionally good cheese, he should look up its record to see what was done to cause it to be better than the average; on the other hand, if a poor cheese is found, its record should be examined and the cause of the trouble located. By so doing, a record will be an education in itself—the cheese-maker will develop, his cheese improve in quality, and both these things will add to his future prosperity.

Below will be found an outline of a very convenient "daily record," giving only the most essential things to be kept on file. Such a record will not be found a burden but rather a pleasure for any cheese-maker to keep. Other things may be added at the maker's pleasure, but care must be taken not to make it too cumbersome for practical use.

Rule a note-book, using the double page, or single sheets of paper large enough, and write neatly at the top, as on accompanying page.

THE CURD TEST.

Provide pint glass jars or porcelain cups sufficient in number to test the milk of at least the number of patrons supplying milk to the factory. A convenient size for the porcelain cup is two inches in diameter and three inches deep. Each jar or cup should be plainly numbered or tagged, and each vessel should have a separate cover to be kept on the jars throughout the test. Provide a tin or galvanized iron box with a neat-fitting cover, large enough to hold the jars or cups. This box should have both water and steam connections. When taking the sample for making the test, place the milk in the cup or jar with the same number as is opposite the patron's name. Place them in the box, adding water to the depth of the milk in the jars or cups. Raise the temperature of the samples to 86 deg. F. When transferring the thermometer from one cup to the other, special care must be taken to sterilize the thermometer each time. When the milk has reached a temperature of 86 deg. F., add one dram of a diluted rennet solution made of one part rennet to twenty-four parts water. The rennet may be stirred in by using a knife with a solid metal handle, or by giving the cup a rotary motion. Care should be taken, if a knife be used, to sterilize the knife between the stirring of each sample so as not to contamin-

NOTE—Write this on the left hand page of the notebook. Extend lines to bottom of the page.

Date—Year. Month	No. of Vat.	Lbs. of Milk	Amt. of Color	Amt. of Rennet	Amt. of Salt	% Acidity at Salting	Time Set	Min. curdling	% Acidity when cut	Time heated at 98°	Time dipped	% Acidity at dipping	Hours cooking in whey	Time		
														Milled	Salted	Press

NOTE—This heading for the right hand side of the double page or sheet.

Flavor of Curd	Condition of Curd	No. of Cheese	Weight of Green Cheese	Weather	Remarks

When properly ruled, each double page or sheet will be sufficient for a month's work.

ate one sample from another. When the samples are firm enough, cut into small pieces with the same knife as was used for stirring in the rennet, using the same precautions to sterilize between the cutting of each sample. Raise the temperature to 98 deg. F. Stir the curd at intervals sufficiently to prevent matting, for three-quarters of an hour.

When the cubes are quite firm, pour off the whey and allow the curd to mat in the bottom of the jars. After the samples stand for a while, more whey can be poured off the curd. The water around the jars should be kept at a temperature of 98 deg. F. for five or six hours. By smelling the curd, bad flavors can be detected which could not be found in the milk. This test is valuable in helping to convince patrons that theiir milk is not in good condition for cheesemaking.

THE PREPARATION AND USE OF A CULTURE.

First provide suitable cans of good tin, which are well soldered, and about twenty inches deep and eight inches in diameter. It is better to have a duplicate set, as this gives a better opportunity for keeping them in good condition. When the milk is in small lots it can be more readily heated and cooled than if kept in larger quantities. For convenience in heating and cooling, a special box large enough to hold the cans containing the culture for one day's use should be provided. This box should be made of wood, or, if made of metal, should be insulated, so as to maintain a constant temperature while the culture is setting. This is essential if best results are to be obtained. The box should be supplied with steam and cold water connections.

Better results may be obtained by using the milk from the same source each day, as we are more likely to get a uniform flavor and acidity from day to day by so doing. After selecting the milk, place the cans in the tank with cold water, and cover the cans with a granite plate, thus guarding against contamination from outside sources. Heat gradually to a temperature of 185 deg. F. This may be done without stirring the milk. Hold at this temperature for a few minutes to make sure that the milk in the cans has reached this temperature. Then run off the hot water and turn on cold water, and cool (in the same manner without stirring the milk) to a temperature of about 60 deg. F. In case proper means for heating and cooling, such as described, are not available, then stirring will be necessary. Now add a small amount of the mother culture sufficient to give the desired acid at the time required for use. In our work we find that about one ounce (by measure) to ten pounds of milk gives very good results. In starting a culture it is advisable to use a commercial or pure culture. These may be obtained from the Bacteriological Department of the College, or from any of the dairy supply houses. Special directions are required for the first propagation of these pure lactic acid "culture-starters." The necessary directions will be given by the manufacturer at the time the culture-starter is procured, and these directions must be followed very carefully. It is advisable to propagate a commercial culture at least two or three times before using. If the culture is to be kept more than 24 hours, it is advisable to set accordingly, by using a lower temperature and using less of the mother culture. Aim to produce the same acidity from day to day. When the culture is first broken up, take out a small quantity to propagate the culture for next day. This small portion of culture is what we call the "mother culture." A glass sealer should be provided for this purpose. The indications of a good culture are as follows: The whole mass is coagulated, no liquid is found on top, and it has a mild acid flavor, pleasant to the taste and smell.

A good culture should be used regularly in Cheddar Cheese Making. The rate used will depend entirely upon the condition of the milk. If the acid development is at or near the proper degree for setting, use one-quarter to one-half per cent; on the other hand, if the milk be very sweet, or possesses tainted or gassy fermentation, use one-half to three-quarters of one per cent of culture.

Milk should be set slightly sweeter when culture is used. With gassy milk its use is especially beneficial. Culture with bad flavor or with too high an acidity should not be used. All utensils must be thoroughly cleansed and sterilized before using in culture making.

CO-OPERATION BETWEEN MAKER AND PATRON.

That there has been a marked improvement in the milk delivered to the factory for cheese-making is quite apparent from the improved quality of the cheese produced, but there is still room for more co-operation between the maker and his patrons; first, by the maker keeping his factory and its surroundings in a better condition as to cleanliness and sanitation, thereby making it a more attractive place, which the farmer can look at with pride instead of disgust; secondly, by returning the by-product, whey, in better condition. This latter can be accomplished only by the pasteurization of the whey and the proper cleaning of the tank. It is useless heating the whey unless it is all removed each day and the tank thoroughly washed.

There can be no hard and fast rules given for heating the whey, as this must be varied according to the conditions at the factory, although there are a few general principles which must be observed if this work is to be done successfully and profitably. The heating should be commenced as soon as possible after the first whey is put into the tank. This should be done for two reasons—first, to take advantage of the temperature the whey is already at; and, second, to prevent the further development of acidity. The whey should be heated to at least 150 deg. F. in order to obtain the best results. Care should be taken not to exceed 160 deg. F., as heating above this temperature will cause the whey to become slimy.

The benefits to be derived from pasteurizing whey are: It conserves the food value of the whey in preventing the development of acid; it ensures a more even distribution of the fat in the whey; it also prevents the spread of contagious disease through the whey when being returned to the farm and fed to young stock; the sweet whey is not so hard on the cans as is sour whey,and the cans are more easily cleaned when the whey is kept clean and sweet. According to experiments made in 1910, the whey may be heated at a cost of from 50c to $1.00 per ton of cheese, according to the efficiency of the equipment of the factory, but since that time costs of fuel and equipment have risen and the present estimated cost is $1.00 to $1.25 per ton of cheese.

MILK FOR CHEESE-MAKING

To obtain the best results, it is necessary to have the milk delivered at the factory clean, sweet, and of good flavor. The evening milk should be cooled to 60 deg. F., or under, and the morning's milk cooled before mixing with the evening's milk. The maker who accepts other than good milk is not acting fairly with the other patrons who furnish a first-class quality of milk for cheese manufacture.

TESTING FOR RIPENESS.

Rennet Test.

The rennet test should always be made after the color is added to the milk. When a number of tests are made, and afterwards poured into the vat without having the color added, white specks are most likely to appear in the cheese.

To make the test, measure exactly eight ounces of milk in an eight-ounce glass, at a temperature of 86 deg. F. Place a piece of match or wood in the milk, then add one dram of rennet, note the time on the second hand of a watch or clock, stir the rennet into the milk for ten seconds, count the time from adding the rennet until the match or piece of wood stopped. When the milk has the required acid, this will take from twenty to twenty-four seconds.

ACIDIMETER.

The ripeness of acidity of milk may be tested also with the acidimeter. No definite degree of acidity can be given as a hard and fast rule to go by. The best rule is to set at that acidity which will allow the curd to remain in the whey from 2½ to 3 hours from the time of adding the rennet, until the whey is removed, with the right degree of acidity developed. This is usually about .17 per cent. on the acidimeter.

If using the acidimeter and making colored cheese, the acidity should be ascertained before adding the color to the milk, as it is more difficult to detect the neutral point with the color added to the milk.

Another point to note carefully when using the acidimeter is the effect of the presence of rainwater in the milk. When the milk is diluted, less milk is taken in the sample, and will show a less degree of acidity than is contained in the milk to the extent of the percentage of dilution, thereby misleading the cheesemaker.

THE USE OF PEPSIN OR OTHER SUBSTITUTES FOR RENNET.

Pepsin in powder or solid form is prepared by dissolving about one-quarter ounce of pepsin in eight ounces of pure water. This solution is then added to one thousand pounds of milk; or, sufficient of it, to coagulate the milk in from twenty-five to thirty minutes.

Liquid rennet substitutes are already prepared for use, and the directions are given by the manufacturer. The quantities usually recommended are from four to five ounces to one thousand pounds of milk. Pepsin does not seem to work so well in very sweet milk as does rennet.

If setting a vat of milk at .17 per cent. acidity by using rennet, for pepsin or other rennet substitutes, the milk should have .18 or .185 per cent. acidity in order to obtain similar results. Care should be taken not to develop too much acid on the milk, as it will injure the quality of the cheese.

SPRING CHEESE.

If color is used it should be thoroughly mixed with the milk before the rennet is added, using one to one and one-half ounces of color per thousand pounds of milk. Add color in amount as the market may require. The use of cheese coloring should be discouraged, as it is a needless expense.

When making early spring cheese it is usually necessary to make a quick-curing cheese in order to reach an early market.

To make this class of cheese it is advisable to use a large quantity of rennet and a small quantity of salt, as this hastens the ripening process and overcomes the tendency of milk at this time to make a dry, hard cheese due to the low per cent. of the fat in the milk and the tendency of this class of milk to develop acid rapidly. Heat the milk to 86 deg. F., and stir slowly while heating. When the desired acidity is obtained, add the rennet, using four or five ounces per thousand pounds of milk, or sufficient to coagulate the milk firm enough for cutting in fifteen or twenty minutes.

Commence to cut early, using the horizontal knife first, cutting slowly lengthwise of the vat.

Then with the perpendicular knife cut crosswise and afterwards lengthwise of the vat. We should advise strongly the use of the ¼-inch wire knife, as this leaves the curd in better condition for the moisture to escape with the least possible loss in the whey, as the cubes are smaller, and more uniform, and are not so easily broken as the larger ones.

Commence stirring at once with agitators or the McPherson rake. Stir carefully for ten or fifteen minutes, then see that the curd is free from the sides of the vat before applying heat. This loosening of the curd from the sides of the vat can be done at this stage with less loss than if done immediately after cutting, as the curd has become somewhat firmer and does not break up so readily. Curds should be handled carefully and in such a manner that the cubes will not be broken nor allowed to mat together. Rough handling or breaking of the curd causes a serious loss to both quality and quantity.

Heat to a temperature of 98 deg. F., The time required to accomplish this heating should be approximately forty-five minutes from the time of cutting the curd.

We formerly advised taking the agitators out soon after heating was completed, with the idea that we were able to firm the curd butter with the small rake, but since the introduction of the ¼-inch knife, we have found that we get better results, with less labor, by allowing the agitators to run for a longer time.

There is nothing gained by harsh treatment of the curd, as such treatment will allow the moisture to escape only in so far as it breaks the curd. It is much better to allow the curd to firm by natural agencies, namely, acid development, heat and rennet action. Acid usually develops very rapidly in the spring, therefore it is necessary to be prepared to remove the whey quickly when sufficient acid has been developed, which may be from .16 to .19 per cent. as shown by the acidimeter. Curds at this stage should be nice and firm (not hard or harsh), and be kept in a loose, open condition in the sink a sufficient length of time to allow the free moisture to escape, as the moisture can be removed at this stage with very much less loss than it can later on. Leave the curd about 8 inches deep in the curd sink. When it is well matted, cut into strips 6 to 8 inches wide and turn upside down, and in about fifteen minutes turn again, piling two deep. Continue turning every ten minutes until the curd is ready to mill. When the curd is well matted and flaky and shows .7 to .8 per cent. of acid, it should be milled, and well stirred afterwards. This stirring should be repeated often enough to prevent the curd matting until ready to salt. This will be when the curd has mellowed down nicely and shows 1 to 1.2 per cent. of acid. Stir and air the curd well before adding the salt, as this improves the texture and flavor of the cheese. Salt at the rate of 1½ to 2 pounds of salt to 1,000 pounds of milk. It is important that the temperature of the curd from dipping to milling should not go below 94 deg. F. After milling, allow the curd to cool gradually to about 85 deg. F. when ready to salt. Put to press at a temperature of 82 deg. to 84 deg. F. Weigh the curd into the hoop, tighten the press gradually and leave the cheese 45 minutes before taking out to dress. When dressing, use plenty of clean, hot water and what are commonly called "skirts." These cloths help to make a good rind on the cheese, keep them clean, and cause the cheese to come out of the hoop more readily. Turn all the cheese in the hoops every morning, and allow no cheese to be taken to the curing-room that do not present a clean, neat appearance.

SUMMER CHEESE.

In making summer cheese, one ounce of color to one thousand pounds of milk is usually sufficient, but this may be varied according to requirements of the market. Use from 3 to 3½ ounces of rennet extract per thousand pounds of milk, or sufficient to coagulate the milk for cutting in 25 to 30 minutes. If this limit is exceeded we have too great a loss in the whey. The cutting and firming of the curd is the same as given for spring cheese.

It may be necessary to raise the cooking temperature slightly higher, as we may be dealing with milk of a different composition from that used in the spring. The acidity should be allowed to develop to such a point that is found from day to day to give the best results in the working of the curd later in the process, aiming to have the curd with good body, well matted and in a flaky condition when ready to mill. At this time it should have an acidity of .7 to .8 per cent. in about two hours from the time of dipping. The curd should be well stirred after milling, and, if cut crosswise of the grain, the stirring may be done better and with much less labor. Curd should be well matured, stirred, aired thoroughly and cooled to a temperature of 85 deg. F. before salting. Use from 2 to 2½ pounds of salt on the curd from one thousand pounds of milk.

FALL CHEESE.

When making fall cheese it is a mistake to use too much culture or to ripen the milk too much, giving the cheese the appearance of having been made from over-ripe milk, which is very objectionable in fall cheese; rather use a smaller amount of culture, not more than one-quarter of one per cent., and add it to the milk when there is a small quantity in the vat, as it starts a gradual fermentation which continues all through the process. Always heat the milk to at least the temperature of the culture before the culture is added. Set slightly sweeter than usual, as we are able to work closer to the "sweet line" all the way through, owing to the fact that we receive the milk in better condition.

GASSY MILK.

The presence of gas in the milk retards the development of acid, and as acid is necessary in the manufacture of cheese, it is advisable to make the conditions as favorable for its development as possible without injury to the body of the curd. To do this, use ½ to ¾ per cent. of good culture, as by so doing there is introduced into the milk an abundance of lactic acid bacteria, which will, under favorable conditions, overcome the gas-producing bacteria.

The next step is to ripen the milk slightly more than usual before setting. When cutting, aim to have the cubes as even in size as possible. Allow the acid to develop slightly further before applying the heat, stir carefully, and heat slowly, aiming to have the curd in normal condition at dipping. Use the same temperature for cooking and the same acid for dipping as with a normal curd. A gassy curd does not require so much stirring as a normal curd, because the moisture leaves it more readily. Pile the curds, before milling, 6 to 8 layers deep; this saves so much piling after milling and is much more convenient to handle; take down and re-pile oftener than with a normal curd. Mill as soon as the curd is well matted and the acidity has developed to .8 to .85 per cent. About half way between milling and salting, commence piling the curd. Allow it to stand 15 or 20 minutes, then spread it out, stir and pile again. Continue to do this until the curd feels mellow. Give plenty of fresh air before salting. Use the normal amount of salt and put to press at a temperature of about 80 deg. F.

OVER-RIPE MILK.

What is over-ripe milk? It is milk with one of the agents used in cheesemaking out of proportion; or milk with the lactic acid developed in too great a degree in order to obtain the very best results in converting the milk into cheese. What are the agents used in separating the solids from the moisture or water content of the milk? They are rennet, heat, and acid development, together with the cutting of the curd to get it into a convenient condition for the escape of the moisture. The heat should not be applied until enough milk is in sight to fill the vat. Why? Because, as we raise the temperature, we make more favorable conditions for the development of acid. When making colored cheese, use 1-8 to 1-4 ounce more coloring per 1,000 lbs. milk, because high acidity tends to cut the color of cheese. Heat as quickly as possible to 80 deg. F., and after testing for acidity, set at this temperature. Why? Because 80 deg. is less favorable for acid development than 86 deg. F., and the time for heating to 86 deg. is saved, and, what is more important, the maker is able to get the rennet added sooner and a larger quantity of it, thereby getting the acid under control more quickly; if not under control, it is difficult to get it to work in conjunction with the other agents which contract and expel moisture from the curd. In handling over-ripe milk it is always advisable to use more rennet—at least one ounce more, per thousand pounds of milk, for several reasons; first, that it may coagulate the milk more quickly second, it gives a firmer curd more quickly, and renders the curd less liable to be broken when handling it, thereby saving to a great extent the great loss which usually is sustained from making over-ripe milk into cheese. It also helps to break down the caseous matter in the cheese, giving it a better texture. Commence cutting the curd early and cut rapidly so as to keep pace with the rapid firming of the curd. If this is not done the curd will get into a condition which makes it very hard to cut properly. Use the ¼-inch knife rather than cut the curd four times, as it leaves the curd more uniform and in better condition than when it is chopped finely. Heat quickly and, if necessary, raise the temperature two or three degrees higher than for normal milk. In extreme cases heat 10 deg. higher than normal.

A great many cheese makers make a mistake at this point by stopping the stirring and running off part of the whey when the curd is quite soft; while the whey is running off, the curd is matting; then they stir it with a little rake and break it up, thereby liberating a lot of the milk solids, giving them a high acid reaction in the whey, and the result is they have a sweet curd and a sweet cheese. The natural tendency for this kind of curd is to run together, so the best way is to keep it stirred in all the whey until it firms a little. Hard raking does not firm the curd except in so far as it breaks the cubes. If agitators are used, the curd can be kept apart and the whey lowered quite soon enough without resorting to this rough handling. One can readily see that if the whey be lowered quite close to the curd while it is in a soft condition that it will be quite difficult to prevent it from matting; and while the maker is keeping it apart with a small rake he is breaking it up, causing a loss, and also causing rough texture in the cheese. It is always advisable to have the whey run down shortly before the dipping point is reached to avoid being caught with too much acid. When the curd is in a soft condition it is advisable to dip with slightly less acid and to keep it in a loose, open condition in the curd sinks until all the surplus moisture is drained from the curd. If the curd is still weak in body, mill slightly earlier than usual. If not, treat as a normal curd. Mature the curd well before salting.

RIPENING OR CURING CHEESE.

The ripening or curing of cheese is one of the most important points in the process, as no matter how well a cheese is made, if the curing is not properly done the quality cannot be the finest. Therefore it is necessary to provide a room where the temperature can be controlled at all times. It is important that some means be provided to control the moisture in the room so as to prevent the growth of mould, which occurs where too much moisture is present. An excessive shrinkage takes place if there be too little moisture in the room. Proper temperature and moisture may be obtained by building an ice chamber in connection with the curing-room and having a free circulation of air over the ice. This cools the air and causes a deposit of moisture on the ice. In putting the cheese in the curing-room, place them straight and even on the shelves and turn them every morning except Sunday. Keep the room well swept and looking clean and tidy. Use good strong cheese-boxes, have them dry, and of such a size as to fit the cheese nicely.

Weigh carefuly and stencil the weights neatly on the boxes. Load cheese on clean wagons, and provide canvas covers to protect them from rain and heat while on the way to the station.

If the cheese are to be kept for two weeks, or longer, at the factory, it will pay to dip the cheese in paraffine wax. A small outfit for this purpose can be bought for about thirty-five dollars. The saving in shrinkage of the cheese will soon pay for the tank and wax used. The cheese should be coated when about one week old.

WHEY BUTTER.

In view of the fact that many inquiries have been made at the O. A.C. concerning the manufacture of whey butter, it is deemed advisable to add some notes on whey butter manufacture that may be of practical use.

The first thing to consider is the amount of butter that can be made from a given quantity of whey.

The average loss of fat in the whey is about .23 per cent. As a pound of fat will make more than a pound of butter, we can get over a quarter of pound of butter from each hundred pounds of whey; in other words, we can make from 2.5 to 3 pounds of butter from each 1,000 pounds of average whey.

Whey butter as a food is worth just as much as the creamery product, although some people are prejudiced against its use, more perhaps because of its name than anything else; hence on the market it does not, as a rule, sell for quite so much money—generally from 1 to 5 cents per pound less than first-grade creamery butter.

Whey butter is not oleomargarine, nor does it "take the place of butter." It **is butter,** although according to law the packages or wrappers must be plainly marked showing what are the contents.

The cheese maker, knowing the amount of whey butter he can make during the season, can calculate about what he can safely expend on a whey butter plant. As to this expenditure, many things will have to be taken into consideration:

(1) **The Building or Room for the Necessary Machinery.**—Owing to the already overcrowded condition of some of the work or make-rooms of factories, extensions or additions would have to be made; or, possibly re-arranging the vats would be all that is necessary to make the required room.

(2) **The Boiler.**—Which should be one of not less than 20 h.p. and capable of carrying 80 pounds steam pressure. Such a size will be necessary for successful running of the average-sized separator. Most machines need only from 25 to 30 pounds of steam pressure to run them. Although all recent makes of whey separators have governors or regulators on them, it will be found that by carrying from 70 to 80 pounds steam at the boiler the separator will run more steadily and better results will be obtained.

(3) **The Capacity of the Separator.**—Do not make the mistake of getting one that is too small in proportion to the work to be done. A cheesemaker generally has about all he can do without separating whey, hence in order to keep up with his work, it will be necessary to have a

machine large enough so that the whey will be separated and all the "washing up" out of the way before it is time to salt the curds. A larger machine is also a saving on the fuel bill, as it takes but very little more steam to run the larger capacity separators than it does the smaller, and with the separating done so much more quickly there is less firing, and less wear and tear on the machinery. Then, too, the more quickly whey can be separated after it is run off the vats, the better will be the quality of the butter, more especially is this so in regard to flavor. When colored cheese are made, and the whey has stood too long before being separated, the butter will be more or less pink in color.

4. **The Initial Cost of the Separator.**—This depends upon the class of machine, as the different manufacturers have their scale of prices set according to the capacity of the separator. The range of prices would be from $665 to $1475.

5. **Tanks, Piping, Valves, etc.**—The cost of the piping and valves would be a local matter, but the price of the tanks would have to be obtained from the manufacturers, and this would depend upon the material out of which the tanks were constructed, size of tank, etc.

For the large reservoir tank, one constructed of galvanized steel will give the best all round results. Such a tank should be made not more than three feet deep, and large enough to contain from 14,000 to 18,000 pounds of whey. The reservoir tank must be thoroughly washed and scalded every day, if a good-flavored butter is desired. If this tank is constructed of steel, it is a simple matter to keep it clean, as the pores of the material will not absorb whey and become sour as a wooden one is likely to do. The tank should be protected, whether inside or outside with a tight-fitting cover to keep out flies and other insects, as well as sand. Sand has a tendency to cut and unduly wear certain parts of the separator, and as the whey butter is for human food, everything the whey comes in contact with must be kept scrupulously clean.

6. **The Installation of the Whey Butter Plant.**—After it has been decided to separate the whey, it is best to call in an experienced man to lay out plans for placing the machinery, and for working out other details in connection with the mechanical end of the business. Most separator companies furnish such help free of charge.

7. **Churn and Churn Equipment.**—The cost of these, like the separator, depends on the make and size of the churn required. Some of the smaller factories use a large-sized hand-power barrel churn. In this case the expense is not very great. Many factories find it more convenient to sell the cream to some near-by creamery, or to ship it further away, when a railroad station is convenient. By selling the cream, a churn room is not required nor a churn needed, and the extra work of churning and handling the butter is saved, as also the cost of butter boxes, wrappers, etc. In fact the difference in price between butter and cream would hardly warrant a maker in expending too much in buttermaking machinery, and all that butter making involves. Some may ship the cream to bakers and confectioners. Sweet whey cream makes excellent ice cream.

8. **Refrigerator, or Cooling Apparatus.**—When butter is made in the summer months some kind of cooling system will have to be provided. If the cream is not churned but otherwise disposed of, all the

necessary cooling can be done quite easily when a good supply of cold water is at hand. Have a water-tight box made with a tight-fitting cover. The box should be made two or three inches above the height of the cans containing cream, with an overflow in the box three or four inches below where the top of the cans would come. This overflow must be large enough to carry off the water faster than it could possibly be run in, in order to guard against a possible chance of flooding the cans of cream. While cooling cans of cream, keep the cold water constantly running in the box, and as the water around the cans becomes warmed, it will rise to the top and flow out through the overflow. In this way the cream will become quickly cooled.

9. **Extra Fuel and Lubricating Oil.**—Lubricating oil is a matter of no small importance, as the best must be had and plenty of it. Such rapidly running machinery as a cream separator must never lack oil for an instant. The fuel bill is not a small one either, for instead of letting the boiler-fire die down, after the curds are cooked, until milling time when the cheesemaker is practically done with the steam for the day, when running the separator, a brisk fire must be kept burning from the time the first whey is run off until the last whey is separated. The time, as mentioned previously, depends largely upon the capacity of the separator used. Roughly estimated, the extra fuel required is probably one-third more than would be used where no whey is separated.

10. **Depreciation of Machinery, Interest on the Investment, and Insurance** are three things in addition which must be taken into consideration. As to depreciation, probably ten per cent. annually would cover this; for interest, allow say five per cent.; for insurance, although a small matter compared with the other two items, there ought to be a certain allowance.

11. **The Cheesemaker's Remuneration.**—If we make a distinction between the man who does the work and the proprietor or owner of the factory, the man who is actually responsible for the running of the separator and all the extra work this places upon him, he ought to be paid from eight to ten cents per pound of butterfat; and when churning is done, from ten to twelve cents per pound for butter made. In some factories a maker has to hire extra help on account of the whey-butter business, in which case the higher named figures would not be enough.

12. **Dealing with the Patrons.**—This in reality ought to be the first consideration, for if a satisfactory arrangement cannot be made that is agreeable both to maker and patrons, the business might better end before it begins.

After the maker is thoroughly convinced that there is money in the whey-butter business, he should call his patrons together and put the matter plainly before them, and when an agreement has been reached that is agreeable to all concerned, the maker should go ahead with the other details of the business. By way of suggestion, several different arrangements between maker and patrons will be very briefly outlined.

In some cases where the maker and the proprietor are one and the same person, and he bears the total expense of the whey-butter plant, then the patrons give him all the whey-butter during the first two seasons. After that, one-half. Some times an arrangement is made whereby the maker continues to receive al lthe whey-butter, but in this case makes the cheese for a sum considerably less per hundred than he otherwise would do.

Sometimes the patrons pay the cheesemaker who operates the separator so much per pound fat skimmed, and they also pay the proprietor a similar amount for the use of the machine, fuel, etc.

The patrons may pay for putting the machine in and pay the maker so much for operating it, the patrons furnishing the extra fuel, etc. This last system is more generally carried out where the patrons own the factory. There are other methods, but mostly they are variations of those given. However, it may be stated that it takes about half of what the whey-butter brings, to pay the running and operating expenses.

Another matter that may be mentioned is with regard to terms made by the separator companies. It is well known that they prefer a cash deal; at the same time they are generally quite willing to instal a plant and take their pay from the proceeds of butter or cream sold each month after the running and operating expenses have been deducted. This is a matter which can be arranged between the proprietor and the agent of the company manufacturing the separator.

When curd sinks are used they should be kept in a thoroughly clean and sanitary condition, so that the whey dripping from the curd may be added to the whey and separated. Do not add the drippings or grease from the press, as this will spoil the flavor of the whey-butter.

Strain the whey through a double thickness of cheese cotton before it enters the bowl of the separator, otherwise the bowl may become clogged with small particles of curdy matter, and a complete separation of the whey cannot be obtained.

If the whey cream is to be sold, cool it to 50 deg. F,. or as cold as well water will cool it, as soon as possible after it comes from the separator. This also applies to cream that is to be held in the factory a few days before churning. At all times keep it cold, and in a clean, sweet place.

Some makers claim that it is not advisable to churn whey cream unless it has been held for two or three days, thinking that by so doing they get a better yield. At the O.A.C. we get excellent results by pasteurizing whey cream immediately it is taken from the separator, and churning it the next day.

In the factory, heat the cream to 170 deg. F. the day before churning; hold at this temperature for fifteen minutes, then quickly cool the cream to about 50 deg. F.; hold over one night, and early the next morning churn it. By churning early in the morning, the maker takes advantage of the cooler atmosphere, when a good, cool butter-room is not part of his equipment; then, too, he is able to get this part of his extra work out of the way before the day's milk begins to arrive.

Skim a rich, heavy cream, testing from 60 to 70 per cent. fat. The aim should be not to lose fat, and to get rid of as much whey as possible. A thin cream, which means that too much whey has been retained in it, is apt to impart to the butter a decided "cheesy" flavor ,especially if the cream be held two or three days before churning Besides the cheesy flavor, there will also be more of the pink color mentioned previously.

Such heavy cream cannot be churned; hence it will have to be thinned with buttermilk or skim milk until the cream tests about 30 per cent. fat. In cases where buttermilk or skim milk is difficult to obtain, good results may be got by simply diluting with good, pure, well water until the cream is of the right consistency. This should be done just previous to churning. When water is used to dilute the cream it may take a little longer to do the churning, otherwise the churning is done quite the same as with ordinary cream.

For shipping the cream, use the ordinary eight-gallon can, which is generally furnished by the creamery to which the cream is shipped. Where the cream is to be made into butter at the factory, it is best handled in cans similar to the common "shot-gun" can, which are about eight or nine inches in diameter, and from eighteen to twenty inches deep. At least a half-dozen or more of such cans will be required, depending on the amount of cream obtained each day, and the length of time between churnings. Cans of this size and shape are more convenient to handle when filled with cream, and when pasteurizing, the cream is more quickly heated, and much more readily cooled than if larger cans are used.

Ice Cream

H. A. Smallfield.

The ice cream industry is becoming one of the important branches of Dairying and each year sees new plants springing up, more ice cream made and sold, and the consuming public realizing more and more that ice cream must no longer be considered a hot weather confection, but rather an all year round food. Extensive researches have demonstrated beyond doubt the value of ice cream in the diet.

It is not the intention in this bulletin to go into all the details of ice cream manufacture. For those wishing a more complete treatment of the subject it is recommended that they purchase one of the recent ice cream text books; and if makers would keep abreast of the progress being made by the industry in all its departments, they are advised to subscribe for and read carefully one or more of the various ice cream trade papers.

Care and Selection of Ingredients.—Select the best quality of dairy products, sugar, stabilizer, flavoring extracts, etc. Inferior ingredients will reflect themselves in the quality of the ice cream. Dairy products should be stored under conditions which will prevent development of off flavors and high acidity. Other ingredients also should be kept dry and free from contamination.

Preparation of Mix.—First of all decide on a standard composition for the ice cream mix and adhere to it as closely as possible from day to day. The minimum per cent of fat allowed in ice cream in Canada is 10 per cent. Commercial ice cream will contain from 10 per cent. to 14 per cent. fat, 8 per cent. to 12 per cent. milk solids-not-fat, 13 per cent. to 15 per cent. sugar, and .4 per cent. to .5 per cent. gelatine.

As the per cent of fat is increased the per cent. of serum solids is decreased and vice versa. The steps involved in calculating the exact quantity of ingredients required to give a definite composition in the mix are too lengthy to include here. Those interested will be furnished with directions for standardizing the mix if they write to the Dairy Department, Ontario Agricultural College, Guelph.

Having determined the quantities of ingredients to use, dump the liquid dairy products into the mixing tank. The pasteurizer serves as a mixing tank. With the coils or agitator in motion add the remainder of the ingredients. Skimmilk powder should be sifted over the surface of the liquid in the pasteurizer. Gelatine may be added in the form of a 10% solution; it may be mixed with part of the sugar, or it may be added directly to the mix in dry form. Adding it dry is just as satisfactory and entails less labor. Add it before starting to heat the mix and allow it to soak a few minutes. Do not add sugar too rapidly and do not dump it all in one place. Where butter is being used it may be cut into small chunks and added to the mix when the temperature reaches 100 deg. F., or, it may be melted in a steam kettle and the liquid butter fat added when the mix reaches pasteurizing temperature.

Pasteurizing and Homogenizing.—Pasteurizing the mix is desirable wherever possible, as it not only destroys a large percentage of bacteria present but also facilitates the solution of the various ingredients and produces a more uniform mix. The mix should be heated to at least 145 deg. F. and held at least 30 minutes where the foregoing temperature is used. Higher temperatures and shorter exposures may be used so long as the holding temperature does not exceed 160 deg. F.

An homogenizer or viscolizer should be in every plant that makes ice cream in commercial quantities. Its use enables the manufacturer to produce a better quality of ice cream and also use butter in the mix when sufficient sweet cream is not available. The mix is run through the homogenizer or viscolizer at a temperature varying from 110 deg. F. to 150 deg. F., and at a pressure varying from 2000 lbs. to 3500 lbs. per square inch. Low temperatures, high pressure, high total solids, and high acidity are factors which tend to produce thick, viscid mixes.

Cooling and Aging.—After homogenizing, the mix should be cooled by passing over a surface coil cooler with water and brine connections, although a coil vat pasteurizer will serve the purpose as a cooler and holding tank. The mix should leave the surface cooler at about 40 deg. F. if possible and be run into holding tanks or milk cans. The mix in the tanks may be further cooled to 32 deg. F. to 36 deg. F. for aging. If stored in cans, the cans should be set in a refrigerated room or in a tank of ice water until ready for freezing.

The mix should be aged for a period of 24 to 36 hours before freezing in order to restore the viscosity destroyed during pasteurizing. Aging the mix improves the body and texture of the ice cream. When natural aging is not possible, the judicious use of "improvers" will aid in obtaining the desired overrun and in giving the proper body and texture.

Aging temperatures should be under 40 deg. F.

Freezing.—Freezing of the mix is an important step in the successful manufacture of ice cream. A mix made of good material and properly processed can be spoiled in the freezer in so far as texture is concerned. The more of the water of the mix that is frozen in the freezer, the smoother will the texture be. If the brine is shut off too soon, or if a long time is required to get the overrun after the brine has been shut off the cream is usually soft when drawn and the texture will not be so smooth as it should be, when hardened.

Under average conditions the following general rules will give good results:

1. Have the temperature of the mix as low as possible when entering the freezer. It should be under 40 deg. F. at least, and better between 32 deg. and 36 deg. F.

2. The temperature of the brine should be about 0 deg. F. Some manufacturers are using a brine temperature as low as 10 deg. below zero.

3. It is important to shut the brine off at the proper point. This is as soon as the mix thickens sufficiently to ribbon or fold on itself when a little is run out of the freezer into a can. The whipping is then continued until the proper overrun is reached.

A mix should be ready to draw from the freezer in about 9 to 12 minutes, if conditions are right. The temperature of the mix, the temperature of the brine, the volume of brine, the composition of the mix, the condition of scrapers, speed of the dasher, and the amount of mix in the freezer, are factors which affect the length of time required to freeze and obtain the desired overrun.

Hardening.—The filled cans, brick-slabs, or packages of ice cream should be transferred to the hardening room as quickly as possible. The temperature of the hardening room should be maintained below 0 deg. F., if possible. Rapid hardening of the ice cream will produce a smoother texture than slow hardening. Where the plant has no hardening room, the ice cream must be hardened by packing with ice and salt. The cans may be packed right in the ice cream tubs, or a specially constructed insulated, wooden box may be used for holding the cans, and the salt and ice.

No attempt is made in this bulletin to give formulas for different flavors of ice cream and sherbets, as a small book could be devoted to that subject alone. The student is referred to the various text books on ice cream making for such formulas.

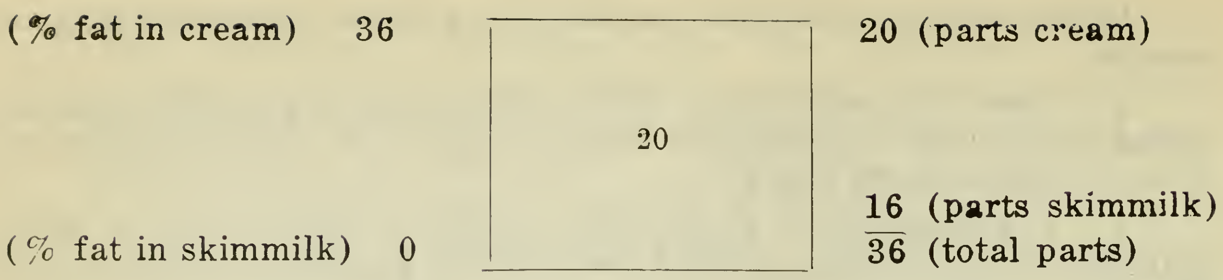
It does seem desirable, however, to include in this bulletin details of the Pearson method of standardizing cream. As the method is used extensively in the standardization of ice cream mixes it is inserted in the ice cream section, as follows:

Example 1.—Given a 36% cream and skimmilk to be mixed to produce a 20 per cent. cream. The weights to be used are determined in the following way:

Draw a rectangle and in the centre place the percentage of fat desired. At the upper left hand corner place the per cent. of fat in the cream which is to be reduced. In the lower left hand corner put the percentage of fat in the milk, which is to be used to standardize the cream.

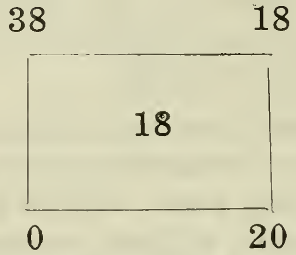
Now, work diagonally across the rectangle substracting the smaller number from the larger and place the differences at the opposite corners.

Example 1, is illustrated as follows:



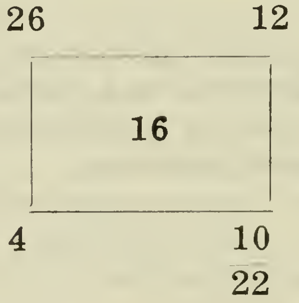
If we mix 20 parts of 36% cream and 16 parts of skimmilk, there will be obtained 36 parts of 20 per cent. cream.
Suppose we require 220 lbs.of 20% cream, then, (220 × 16) ÷ 36= 97.77 lbs. the weight of skimmilk required; and, (220 × 20) ÷ 36= 122.22 lbs., the weight of 36% cream required to make 220 lbs. of 20% cream.

Example 2.—Given 367 lbs. of 38 per cent. cream to be reduced by skim milk to an 18 per cent. cream, the figures will be:



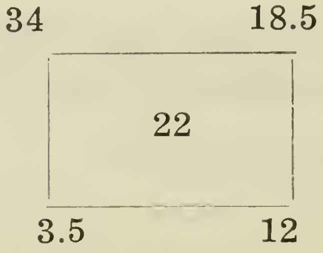
367×20÷18=407.77 lbs., the weight of skim milk required.

Example 3.—Given a 26 per cent. cream and a 4 per cent. milk to be mixed to produce a 16 per cent. cream, the figure will be:



Thus we see that by mixing 12 lbs. of 26 per cent. cream and 10 lbs. of 4 per cent. milk there will be obtained 22 lbs. of 16 per cent. cream. But supposing we require 110 lbs. of 16 per cent cream, 110 × 12 ÷ 22 = 60 lbs., the weight of 26 per cent., cream, and 110×10÷22=50 lbs. of 4 per cent. milk to make 110 lbs. of 16 per cent. cream.

Example 4.—Given 264 lbs. of 34 per cent. cream to be reduced by 3.5 per cent. milk to a 22 per cent. cream, the figure will be:



264×12÷18.5=171.24 lbs., the weight of 3.5 per cent. milk required.

The examples given cover nearly all conditions that may arise in standardizing cream. The same method may be used when determining the weight of skimmilk and skimmilk powder, or condensed skimmilk required for an ice cream mix.

Farm Buttermaking

Bella Millar.

A dairy instructor once said "Buttermaking begins in the stable, but it does not end until the finished product reaches the table of the consumer." Realizing the truth of that statement, care should be exercised in every step of the work and the dairyman's watchword, "Cleanliness," should be adopted.

In any line of work it is necessary to have good raw material in order to make a first-class article. In the manufacture of butter, if the raw material, the milk, does not receive proper care, the most skilful maker cannot produce the best quality of butter.

"Prevention is better than cure," thus every effort should be made to keep dust and dirt out of the milk pail. As soon as possible after milking, remove the milk from the stable and strain it through a strainer that is perfectly clean and sufficiently fine to prevent tiny particles being carried through.

CREAMING THE MILK.

Cream separators are very largely used on farms today, and have many advantages over the gravity system of creaming milk. However, some still use shallow pans and deep cans for creaming purposes.

Shallow Pans. When using shallow pans, the milk should be strained into the pans as soon as possible after milking, and then be allowed to stand perfectly still in a pure air, free from draughts, at a temperature of about 50 deg. to 60 deg. F. for 24 to 48 hours.

Remove the cream while sweet by first loosening the cream from the pans by means of a thin bladed knife; then tip the pan and allow just enough skim milk to run over to wet the tin before gliding the layer of cream into the cream can.

Deep Setting System. The day is past for use of the shallow pan system for creaming milk. If you have not a separator, then use the deep setting system. When using this method, the cans of milk should be placed in cold water and kept at a temperature of 45 deg. F., or lower, for 24 to 36 hours. By this system ice is required, unless the water be cold enough to cool the milk to, and maintain it at, 45 deg. F. while creaming. If the cans are not provided with taps at the bottom, a coneshaped dipper should be used for removing the cream. Loosen the cream from the can with a knife. Dip the skimmer in skim milk or water then lower it, point first, into the can, and allow the cream to flow evenly into it.

The loss of fat in the skim milk by gravity creaming, even under the best conditions, is much greater than when centrifugal force by means of a cream separator is applied.

CREAM SEPARATORS.

The surroundings of a separator, as well as all its parts, should be kept clean.

Immediately after separating, the cream should be cooled quickly to at least 55 deg. before adding it to the cream can.

The cream should be of such richness that from 3 to 3½ lbs. of butter can be made from one gallon of cream; or, the cream should contain from 25 to 30 per cent. butter fat. This can be regulated by the screw on the separator bowl.

Taking a rich cream for buttermaking means less labor, lower churning temperatures, and less loss in the buttermilk.

CARE AND RIPENING OF CREAM.

The cream can should be large enough to hold the cream for one churning and should be provided with a cover.

A simple and cheap cream stirrer consists of a saucer-shapel piece of tin about three inches in diameter with a long handle of heavy iron (tinned) fastened to the centre of it.

When collecting cream for a churning, care should be taken to keep it in a clean, cool place, and to stir it thoroughly from the bottom of the can every time fresh cream is added.

Cream may be churned sweet or it may be ripened. If ripened cream is wanted, only a mild acid flavor should be developed.

CREAM RIPENING.

Natural Ripening. In farm buttermaking, cream is very often ripened naturally, that is, no "culture" or "starter" is added, but the lactic acid bacteria present in the cream are allowed to develop. This method may be used, if the flavor is satisfactory.

Ripening by Using Cultures. A culture may be obtained from the Bacteriological Department at the College, or from a dairy supply house and directions for its propagation and use are sent out with it.

To carry on a culture from day to day: pasteurize skimmilk by heating it to 180 or 185 deg. F., hold it at that temperature for 30 minutes, then cool it to 60 to 70 deg. and add from one to two ounces of culture for each ten pounds of milk.

Let it stand undisturbed until next day, when it should be nicely coagulated and ready for use.

By using a culture to assist in cream ripening, the buttermaker has more control of the flavor and is able to make a more uniform product.

In farm dairy work some sour cream, sour skimmilk, or buttermilk may be used, if the flavor be all right. One method is to add one or two cupfuls of culture to the cream can when beginning to collect cream for churning. By doing this the sweet cream becomes inoculated with bacteria that will produce a desirable flavor.

Another method is to keep the cream sweet until twenty-four hours before churning, then heat it to 65 deg. F. and add from one cup to one pint of culture for each gallon of cream. When the cream begins to thicken, cool it to churning temperature, or lower, and hold it at that temperature for several hours. It is usually held over night and churned the next morning.

Pasteurize and Add Culture. By this method we have the greatest control of the flavors, but more labor is involved.

Place the can of cream in a vessel of hot water on the stove. Bring the cream to a temperature of 145 deg. to 150 deg. F. Hold it at that temperature for 30 minutes or heat to 170 deg. and hold for 10 minutes, then cool rapidly to 60 deg. or 65 deg., and add a culture to ripen the cream.

Cream from cows that have been a long time in milk is sometimes difficult to churn and can be rendered churnable by means of pasteurization. Bad flavors are, to a certain extent, eliminated by this treatment.

Sometimes cream held at a low temperature develops a bitter flavor. The trouble may be kept in check by keeping the cream at a higher temperature to encourage the development of the lactic acid bacteria, which cause the souring; or, pasteurization may be resorted to.

Cream when ready for churning should have a pleasant acid taste and smell. It should be smooth and glossy and perfectly free from lumps. If for any reason a churning is put off for a day, the development of acid can be checked by holding the cream at a very low temperature.

There will be an excessive loss of fat in the buttermilk if sweet cream is added to the ripened cream just before churning.

CHURNING.

On many thermometers at 60 or 62 deg. the word "Churning" is printed. The manufacturers placed it there as a guide but many have mistaken it for a rule.

There is no standard temperature for churning, as conditions vary and many things should be taken into consideration; for example, low churning temperatures may be used when we have such conditions as rich cream, not too much in the churn, succulent feed, and cows fresh in milk.

Choose the temperature that will bring the butter in firm granules in from 20 to 30 minutes.

A range of temperatures that will cover most farm conditions would be—52 to 58 deg. F. in summer, and 56 to 64 in winter.

In farm dairies the barrel churn is mostly used, and having it about one-third full will make the work easier.

Always strain the cream into the churn using a perforated tin strainer.

When churning a ripened cream, it will be necessary to pull the plug a few times in the early stages of the churning to allow the gases to escape.

When the granules of butter are about one-half the size of wheat grain, add a couple of quarts of water several degrees colder than the temperature of the cream and continue churning until the granules are the size of wheat grains, when the churning as a rule is completed.

If butter comes with the first drawn buttermilk, it is a sign that the churning is not quite completed. Give a few more turns to the churn.

WASHING THE BUTTER.

After drawing the buttermilk, rinse the butter with two or three quarts of water before putting on the wash water.

In winter, it is necessary to temper the wash water, taking into consideration the condition of the butter and the temperature of the room. Choose such a temperature that the butter will be in condition for working.

Always put in plenty of water, revolve the churn quickly about a dozen times, then allow the wash water to drain off. One wash water will be sufficient, if the water comes away clear, and the butter is firm.

SALTING AND WORKING THE BUTTER.

Salt to suit the customer, or market, using a good dairy salt. Although some markets require three-fourths of an ounce to the pound of butter, others prefer less.

Some buttermakers weigh the butter before salting while others estimate the amount of salt required from previous churnings.

Another method is to weigh the cream and test it for fat. For example, 20 lbs. of cream testing 30% fat, means that the cream contains 6 lbs. of fat and this will make about 7 lbs. of butter.

The butter may be salted on the worker or in the churn.

Salting on the Worker. The lever butter worker is inexpensive and suitable for farm dairy work. It consists of a V-shaped table, simple in construction, and a pole or lever for pressing the butter.

Spread the butter evenly over the worker. Sift on the salt, fold over the butter, and work, by using only gentle pressure. Other methods, such as a sliding or cutting movement, injure the texture of the butter.

If the butter is too hard or too soft, give but a small amount of working, put the butter in a suitable place until it is of proper firmness, then finish the working.

The salt should be evenly distributed, otherwise the butter will be uneven in color.

SALTING IN THE CHURN.

Have the butter in an even layer over the bottom of the churn. Sift over it one-half the amount of salt required, tip the churn forward to cause the butter to lap over. Sift on some more of the salt, tip the churn backward to cause the butter to fall over, then add the remainder of the salt. Tip the churn back and forth a few times, then put on the lid, and give a few revolutions, very slowly.

PRINTING AND PACKING BUTTER.

All butter packages should be neat and attractive. The one pound brick print is the style most used. It is filled by pressing the printer down into the butter, then cutting off the surplus butter with a ladle. The print should weigh 16¼ oz. when made.

The parchment paper should be of good quality, of proper size, and should be dipped in cold water before wrapping it on the butter.

On the average farm it requires more than one churning to fill a large butter package, therefore great care should be taken in order that the flavor, color, and salt shall be uniform throughout the box or crock. Line butter boxes with heavy parchment paper. Crocks should be well glazed, having no breaks or cracks.

As large packages are often held for some time, endeavor to make the best quality of butter for packing. Pasteurizing the cream, and washing and working the butter twice are means that may be employed in the manufacture of butter for packing.

The place of storage is important, and should be clean, cool, and of even temperature.

Protect the packages in transit from sun, dust and rain.

The object should be to get the butter to the consumer in the best condition possible.

LONG CHURNINGS.

A great many of the long churnings are caused by having too much cream in the churn. Another cause of long churning is low temperature of cream. If, after churning about thirty minutes, there is no sign of butter coming, raise the temperature of the cream a few degrees. Take the cream from the churn, place the can in a vessel of warm water and stir the cream until the required temperature is reached.

With very thin cream it is difficult to gather the butter and it may be necessary to draw off part of the buttermilk and continue the work, revolving the churn slowly.

If the butter breaks and will not gather, but remains about the size of clover seed, take the temperature of the contents of the churn, add a quart or two of water a few degrees warmer, revolve the churn a few times, let it stand a minute or two, then draw off part of the diluted buttermilk and continue the churning.

If a rich cream thickens during the process of churning and concussion ceases, add enough water at the same temperature to dilute it so that it will drop again.

Difficulty in churning may be the result of a number of conditions, but can be avoided if a little thought is given to the question.

THE CARE OF THE DAIRY UTENSILS.

Dairy tinware should be rinsed in luke-warm water, then be washed in hot water containing a little washing soda, using a brush on both the inside and outside. Next, scald thoroughly with boiling water, and place where they will drain and dry. Sunshine and fresh air are beneficial.

The churn should be scalded with boiling water, then cooled with cold water before using. After using, remove particles of butter with hot water. Wash with hot water that contains a little washing soda, then scald with boiling water. Leave the lid off when not in use.

The butter worker, ladle, and printer should be scalded with hot water, scoured with salt, and cooled with cold water before using. After using, remove any butter with hot water to which has been added a little washing soda or other cleanser suitable for dairy utensils, then scald with boiling water. Place the woodenware where it will dry, but do not put it in the sun, or it will warp and crack.

Dairy Farm Cheese

Bella Millar.

A cheese of the "Cheddar" type is a suitable kind to make on the farm when a long-keeping cheese is desired.

Proper appliances for cheese-making lessen the labor to a great extent, but cheese can be made in the home with the utensils on hand.

It will be necessary to secure a few ounces of rennet extract and a strong cheese hoop or mould.

For each pound of cheese required, take from 10 to 12 pounds of milk. The milk should be of good quality, clean and sweet, as it is impossible to make the cheese of any better quality than the milk from which it is made.

Take the fresh morning's milk and mix it with the night's milk in a vat, or some vessel suitable for holding milk; a clean wash boiler will answer the purpose. Heat the milk to 86 deg. F. by placing a clean can of hot water in it, or by setting the vessel containing the milk on the stove and stirring until the desired temperature is reached.

If colored cheese is wanted, use one teaspoonful of cheese coloring for each 100 lbs. of milk. Add the coloring to a dipperful of milk and mix it thoroughly with the milk in the vat before adding the rennet.

Use one teaspoonful of rennet for every 25 lbs. of milk. Dilute the rennet with a pint of cold water and mix it thoroughly through the milk by stirring with a dipper for about three minutes.

Cover the vat until coagulation takes place, which will be in about twenty minutes, depending on the ripeness of the milk; the sweeter the milk, the longer the time required.

To ascertain when the curd is sufficiently coagulated for cutting push the forefinger into the curd at an angle of 45 deg., until the thumb touches it, make a slight break in the curd with the thumb, then gently move the finger forward. If the curd breaks clean across the finger without any flakes remaining on it, it is ready to be cut.

For cutting, regular curd knives are best. Use the horizontal knife first cutting lenghtwise of the vat, then cut both lengthwise and crosswise with the perpendicular knife. This gives small cubes of even size.

When curd knives are not available, a long-bladed knife may be used, cutting the curd lengthwise and crosswise of the vat in strips about one-third of an inch wide, then cut horizontally. By this method it is difficult to cut the curd evenly.

After the curd has been cut, it should be gently stirred with the hand, or with a small wooden rake for ten minutes before applying heat.

Heat the curd to 98 deg., taking about 30 minutes to do so. Continue stirring until the curd is ready for dipping; this is usually about 2¾ to 3 hours, from the time the vat was set.

When the curd becomes firm and springy and falls apart when a handful is pressed together, it is ready to have the whey removed.

After drawing off the whey, stir the curd over once, then pile it evenly at one end of the vat and cover it with a heavy cotton cover.

In about 20 minutes the curd will be well matted and should be cut into blocks about four inches square and turned over.

Turn the blocks every 20 minutes until the curd becomes flaky when it is ready for milling (this usually takes about one and one-half hours after dipping).

A knife may be used instead of a curd mill, cutting the curd into strips about the thickness of your finger. Stir the curd well, then apply salt at the rate of one ounce for each 25 pounds of milk used. Sprinkle the salt well over the curd, mix it thoroughly, and when the salt is dissolved, the curd will be ready to put to press. Between 80 and 84 deg. F. will be suitable temperature to have the curd at this stage.

The cheese hoop, or hoops, should be made of heavy tin with two handles on the outside. A suitable size for home use would be 7 to 8 inches in diameter and 12 or 14 inches high. It is also necessary to have a wooden follower, which will fit nicely on the inside of the hoop.

Place a piece of cotton at the bottom of the hoop, as a temporary cap, then put the cheesecloth bandage inside the hoop. Carefully pack in the curd, fold over the end of the bandage, place on top a piece of cotton similar to the one at the bottom, then put on the wooden follower and put to press.

If a press with a screw is not available use a lever press. Take a piece of scantling 10 or 12 feet long for a lever. Place the cheese hoop on a strong box about three feet from the wall. Nail to the wall a piece of scantling, and under it put one end of the lever. Put a block of wood on top of the follower for the lever to rest on. A pail containing stones or iron may be used for weight. Do not apply full pressure at first.

In three-quarters of an hour the cheese may be taken from the press, the bandages wet with hot water, pulled up smoothly, and trimmed neatly, allowing one half inch to lap at the ends. Cover the ends with circles of stiffened cheese-cloth; over that place a piece of cotton dipped in hot water. Return the cheese to the press until the following morning, when they should be turned in the hoops and pressure continued a few hours longer.

After removing the cheese from the press, place them in a cool, dry cellar to ripen.

Turn the cheese end for end on the shelf every day for a month and afterwards occasionally. These cheese will be ready for use in about six or eight weeks.

To prevent the cheese moulding and to keep them from drying too much they may be dipped in hot, melted paraffine wax.

Soft Cheese Making

Bella Millar.

Soft cheese is made from cream, whole milk, skimmilk, and buttermilk and by making slight variations in the method of manufacture a great variety may be made.

These cheese contain a high percentage of moisture and will not keep long, therefore it is necessary to have a ready market for them.

It is well to have, "Keep in a cool place until used," and "Use while fresh" printed on the soft cheese wrappers.

Soft cheese is used as a spread on bread and biscuits. It is also used in sandwich fillings and salads.

Soft cheese may be made from raw milk or cream but a better and more uniform quality of cheese is made from pasteurized milk or cream.

Milk or cream may be pasteurized by heating it to a temperature of 145 deg. and holding it at that temperature for thirty minutes before cooling it.

FRESH CAMEMBERT CHEESE.

Apparatus Required. ½pint bottle of rennet.
1 measuring cylinder graduated in c.c.'s or 1 teaspoon.
1 thermometer. I dipper.
1 granite pail of convenient size to hold the milk.
Straw mats, size 13 inches by 9 inches.
Boards 14 inches by 8 inches, ½ inch thick.
Moulds, small size, 4 inches high, 4 inches in diameter.
Moulds, large size, 5 inches high, 5 inches in diameter.

Process of Manufacture. Five pounds, or two quarts of new milk are required to make one large size, or two small size Camembert cheese.

Bring the milk to a temperature of 86 deg. To each 10 lbs. or 1 gallon of milk add 10 c.c. or 1 tablespoonful of culture (starter). Then add 1 c.c. or 20 drops of rennet diluted with at least twenty times its volume of cold water.

Stir for five minutes and then stir over the surface with a wooden paddle for two minutes, to prevent the cream from rising.

Cover the pail and leave till coagulation has taken place, which will be in about one hour. The correct stage is reached when the curd breaks easily over the finger.

Scald the required number of straw mats, boards, and moulds, then cool them in water.Place the boards on a drainer with the straw mats and moulds on top. Next, ladle out with a dipper a little curd into each mould, and repeat the same every 20 minutes, until all the curd is transferred and the moulds are full. In ladling the curd care should be taken not to break it, but obtain it in thin slices. When all the curd has been filled into the moulds, turn the cheese, by putting a straw mat and board on top and turning over.

Leave the cheese on the drainer till the whey has drained off and the cheese are firm enough to turn by hand. After turning, the cheese is left in the mould for six hours longer, when the mould can be removed, and in another six hours the cheese is ready to salt.

Salting is done by rubbing about ½ oz. of salt on the outside of each large cheese and ¼ oz. for the small size. After salting, the cheese are left on the straw mats for 12 hours, where further draining takes place. When the cheese is sold fresh, it is now ready to pack and send away.

NOTE.—The room in which the cheese are made should have a temperature from 62 deg. to 70 deg. F.

When making ripened Camembert cheese the large-size moulds should be used.

GERVAIS CREAM CHEESE.

Apparatus Required. ½ pint bottle rennet.

1 measuring cylinder graduated in c.c.'s, or 1 teaspoon.

1 thermometer. 1 dipper.

1 granite pail of convenient size, to hold milk and cream.

Moulds—2½ inches high by 2 1-8 inches in diameter singly or in a group of six.

Straw mat and board as in Camembert cheese.

Strips of blotting paper 2½ inches by 7½ inches.

Cloths made of duck material 27 inches square.

Process of Manufacture. This cheese is made from a mixture of milk and cream, the mixture testing about 10% fat. Bring the required quantity to a temperature of 70 to 80 deg. F. (depending on the temperature of the room) add 1 c.c. of culture for each pound and 1 c.c. (20 drops) of rennet for every 10 pounds of the mixture. The rennet should be diluted with about 20 parts of cold water before stirring it into the milk. In 4 to 6 hours, or when the curd is firm enough, ladle it into a cloth placed over a basin.

The cloths should then be hung by the four corners and left to drain over night. In the morning, open out the cloths and scrape down the sides to aid draining. Repeat the scraping at intervals, until the cheese is firm enough to salt.

Turn the curd out of the cloths into a basin and salt at the rate of 1 oz. to 4 lbs. of curd. The salt, which should be fine dairy salt, must be worked in well and the cheese left for a short time for the salt to dissolve before putting it into the moulds. The moulds should be lined with clean, white blotting paper and placed on a scalded straw mat, or cloth, and the cheese pressed in solidly. The cheese may then be taken out of the mould, wrapped, and sold.

NOTE.—Coloring may be done by adding cheese annatto, which somewhat improves the look of the cheese. Use about 1 c.c. or 20 drops coloring for each gallon of milk and cream.

DOUBLE CREAM CHEESE.

Apparatus Required. ½ pint bottle of rennet.

½ pint bottle of cheese annatto.

Suitable pail for holding cream.

1 thermometer. 1 dipper.

1 measuring cylinder graduated in c.c.'s or 1 teaspoon.

Moulds—size 2 inches by 3½ inches, 1¼ inches deep.

Cloths of duck material, size 27 inches square.

Muslin cloth, greaseproof paper, boards and weights.

Process of Manufacture. Take any quantity of cream testing about 22 per cent. fat. Have the cream at a temperature between 70 deg. and 80 deg., depending on the room in which the cheese is to be set. When the cream is at the correct temperature, add the required quantity of culture. Cheese color may then be added if required. (About 1 c.c. or 20 drops of color to 10 lbs. of cream will usually give satisfaction.)

Rennet is next added at the rate of 3½ c.c. or 1 small teaspoonful to 10 lbs. of cream, after diluting it in twenty times its volume of cold water. Stir into the cream.

In about four to six hours, when the cream has thickened, ladle into cloths and hang up in a dry place. It is advisable not to put too much into one cloth as it will be likely to develop too much acid before draining.

The next morning open the cloths and scrape the sides to facilitate draining, then hang up again. Repeat the scraping at intervals, until the curd is fairly firm. Then turn the curd out into a muslin, and salt the curd by adding 1 oz. of salt to every 4 lbs. and mixing it well into the curd. Fold the cloth over the curd, place on a board having another board and weight on top.

When the curd is ready to mould, it should be of a thick, pasty consistency but not sticky. Line the tin mould with grease-proof paper and press the cheese in with a knife, making the curd quite flat on top. Fold over the ends of the paper and shake the cheese out of the mould. They are then ready to be eaten. If kept, they should be put in a refrigerator or cold storage until used.

NEUFCHATEL CHEESE.

This cheese is made from whole milk or whole milk with cream added to bring the test up to between 4 per cent. and 5 per cent. fat.

To 10 pounds of pasteurized milk at 70 deg. add about an ounce of culture or good flavoured sour skimmilk. Then add 3 to 5 drops of rennet diluted with cold water. Stir for a few minutes then cover and leave undisturbed until coagulated.

As it requires 14 to 18 hours for coagulation it is usually set late in the afternoon and ladled the next morning.

Ladle the curd into a cotton cloth to drain. When the free whey has drained off, lift one side of the cloth to cause the curd to roll to the centre, then lift the other side. This hastens the draining. When the curd becomes firmer slight pressure may be applied.

When sufficiently drained, salt at the rate of 1 ounce of salt to 4 pounds of cheese, mixing thoroughly. When the salt is dissolved the cheese is ready to be put up in packages suitable for market.

FANCY CREAM CHEESE.

Neufchatel cheese is used as a base for a variety of fancy cheese by adding such flavorings as pimentos, olives, or nuts. These should be chopped finely and well mixed through the cheese.

COTTAGE CHEESE.

Cottage cheese is made from skimmilk and is easily prepared in the home.

It is an inexpensive food and may be used in many ways. It is often used as a substitute for meat on account of its high protein content.

To each 10 pounds of skimmilk at 70 deg., add 2 ounces of culture and let it stand until next morning when it should be nicely coagulated.

If a higher temperature and a larger amount of culture are used, milk set in the morning may be made into cheese in the afternoon.

If the milk has been set in a can or pail, stir the curd gently to break it up, then heat it by placing the can in hot water (150 deg.)

The curd is stirred carefully during the heating process and the temperature raised gradually.

When about 100 deg. there is usually a good separation of curd and whey. Remove the can from the hot water. If the curd be firm enough, drain it by pouring it out on a rack covered with cheesecloth of good quality.

When the curd is dry enough salt at the rate of 1 ounce of salt to 5 pounds of cheese and then add about an ounce of cream to each pound of cheese.These should be well mixed through the cheese. After the salt is dissolved the cheese should be packaged and cooled.

When large quantities of Cottage cheese are made a cheese vat is used and the curd is cut with knives the same as when making Cheddar cheese. By this method the pieces of curd are large and even in size.

The curd is heated to 110 deg. to 120 deg. F. (sometimes higher.) To judge the proper time for the removal of the whey, put a handful of curd into cold water. If, after leaving it for a minute, it is of the desired firmness, the whey should be drained, or the curd dipped, into a curd sink covered with a drainer cloth.

When the whey has drained, wash the curd using three waters. Have the first about 100 deg., the second 60 deg. and use cold water for the third. Drain the curd thoroughly before salting and creaming.

Small paper containers well coated with paraffine wax make attractive packages for the retail trade.

NOTE.—A few drops of cheese colouring improves the colour of the cheese.

A small amount of rennet may be added to the milk at the time of adding the culture. A lower heating temperature is used for a curd of this kind.

BUTTERMILK CHEESE.

Buttermilk cheese is made by heating the buttermlik to a temperature of 130 to 140 deg. F., holding at that temperature for about an hour, then draining off the whey.

During the heating process the buttermilk should be stirred just enough to ensure even heating. After leaving it undisturbed for about an hour it should be dipped or poured out on a draining rack which is covered with a cotton cloth.

When sufficiently drained the curd should be salted at the rate of 1 oz. of salt to 4 or 5 lbs. of curd. The addition of about 1 oz. of cream to each pound of curd makes a richer cheese.

These directions are suitable for raw-cream, buttermilk, or for buttermilk from cream that was sweet when it was pasteurized and afterwards ripened.

If the buttermilk is from cream that was ripe when is was pasteurized the curd particles will be very fine and it is necessary to use a different method of making in order to have good results. This was worked out by the Wisconsin Agricultural Experiment Station, and is valuable for creamerymen.

Add a caustic soda solution to the buttermilk to completely neutralize the acid and then acidulate it with hydrochloric acid before applying heat.

The caustic soda is first dissolved in an equal weight of water by adding the dry alkali to the water. The acid is also diluted in an equal volume of cold water.

First test the buttermilk for acidity in order to know how much of the alkali solution will be required.

Forty parts of weight of dry alkali will neutralize ninety parts by per cent. acidity contains 7.5 lbs. of lactic acid. For neutralizing 7.5 lbs. weight of lactic acid For example, 1,000 lbs. of buttermilk testing .75 of lactic acid it will require 3.3 lbs. of caustic soda or 6.6 lbs. of the caustic soda solution.

Trya small amount in a cup, and if the buttermilk shows a permanent pink color when a few drops of phenolphthalein indicator are added, enough alkali has been used.

It will require two and a half to three times as much dilute acid as alkali used. To determine if enough has been added, take a small amount of buttermilk in a shallow dish and hold it for a few minutes in water about 145 to 150 deg. F. Enough acid has been added if the whey separates clear. If the whey is not clear more acid should be added in small amounts until a clear separation is obtained. The buttermilk is now ready for heating and the directions already given for heating, draining, and salting should be followed.

CLUB CHEESE.

This is a very popular variety of fancy cheese and is made from ripened cheddar cheese.

Take one pound of cheese, remove the rind, then cut the cheese in pieces and put it through a food chopper.

To this, add two level tablespoonfuls of butter and put it through the chopper again.

Add ¼ cup of cream and mix thoroughly. Pack the cheese in small jars, or put it up in small blocks and wrap them in tinfoil.

Either butter or cream may be used alone, and the amounts may be varied to suit conditions, such as the dryness of the cheese or the preference of the consumer.

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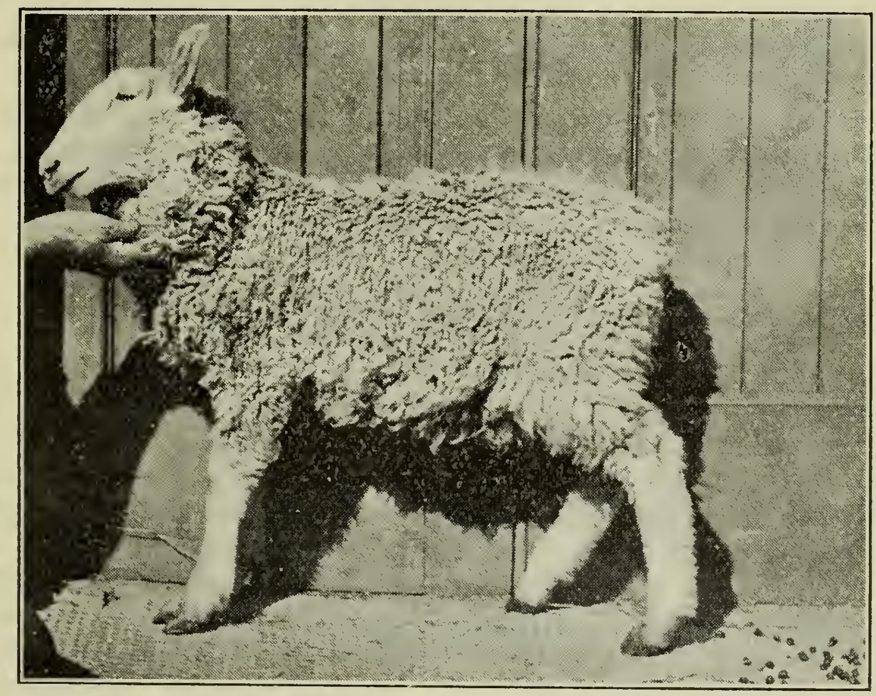
BULLETIN No. 337] [JULY, 1928

Ontario Department of Agriculture

PARASITES INJURIOUS TO SHEEP

LIONEL STEVENSON, Provincial Zoologist.



THE WORK OF THE BREEDER AND THE FEEDER DEFEATED.

This pure bred ram lamb had everything that breeding and feeding could give him, but the parasites claimed him for their own, and when the autopsy was over, and the worms counted, the bystanders understood why the lamb was a 25 pound runt when seven months old. The tapeworms, stomach worms, nodular worms and the whip worms each hold a first mortgage on this lamb's life. The man that raised this lamb and thought he owned it, lost capital, time and profit, all of which might have been saved by simple treatment.

MORAL—Why work for worms, it would be better to give the sheep the protection they need.

THE SHEEP PARASITE HANDICAP.

The toll taken by the parasites, has in many instances been so great, that some farmers have become discouraged and quit raising sheep. Unfortunately, these discouraged sheepmen went out of the business as they went in, entirely ignorant of the parasitic handicap. Had they known what was making their sheep flock less desirable than the other classes of livestock, they would have changed their methods of management and made it possible for the sheep to pay them satisfactory profit. The farms of Ontario produce approximately 1,000,000 lambs each year, these should have a sale value at six months or less old of $12,000,000.00. Unfortunately, our lambs do not average $12.00 each when six months or less old, $8.00 per head would be nearer the average sale price. There is a difference between $8.00 and $12.00, and there is a difference between eight million dollars and twelve million dollars. Various influences are at work to keep a lamb from weighing 100 pounds when it is six months old. Among these influences we have poor breeding, poor feeding and parasitic infestation. Of these three deterring influences the parasites are doing more to make an unthrifty runt of the lamb and an undesirable cull out of the sheep, than either poor breeding or poor feeding. It is conceded by the best veterinarians and sheepmen that of all sheep troubles, at least seventy-five per cent. of all losses are traceable to parasites.

When the life histories of all the parasites are completely known, methods of management can be evolved, to aid in the control or eradication of these pests. There are still many missing links in life histories of the sheep parasites and much careful study has yet to be done before the highest efficiency in the prevention and treatment of sheep parasitosis is attained.

Internal parasites work in an insidious way, they are hidden from view, unseen and unsuspected by the unenlightened sheep owner, they carry on their life of robbery and poisoning. They take the sheep's blood, its food and also pollute the victim with their toxins.

Susceptibility of Sheep to Parasitism.

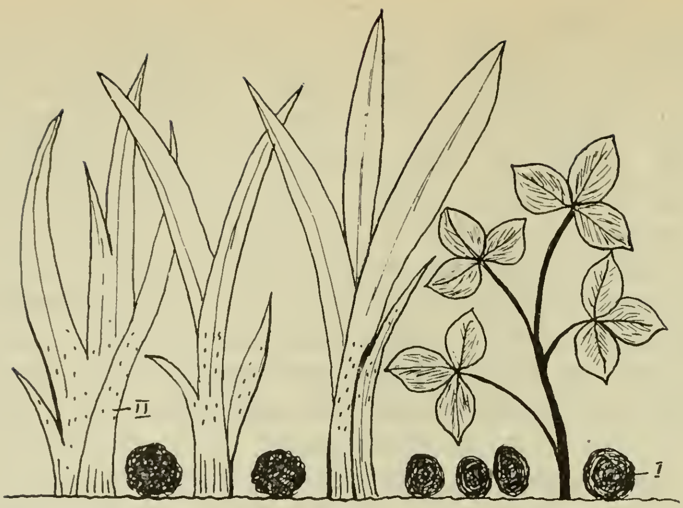
The thin skin and woolly coat covering of the young lamb offers a protected and bountiful feeding ground to such parasites as keds, ticks, lice and mange mites, that attack the sheep. The warm woolly covering is appreciated by the parasites just as much as it is by the lamb, in that it keeps the parasites warm, supplies part of their living, and an excellent place in which to rear other generations of parasites. The blood vessels of the sheep's thin skin and underlying tissues, supply an ever-running fountain of food, always in easy reach of the blood sucking proboscis of the parasite. Nothing could be easier for the parasite, food, shelter, and warmth supplied free, little wonder parasites flourish. Internally conditions also favour the parasite. The abomasum, with its warmth, wealth of food, juicy and easily penerated mucous membrane, offers a feeding ground that no stomach worm would refuse. The intestine, with its bountiful supply of reduced foods (prepared for the lamb), offers a refuge, where the tape worm can, without effort on its own part, grow to be yards and yards in length. For the worms that like a little more air than is available in the lamb's stomach or intestine, the lungs offer a home that is not to be sneared at; food, warmth, shelter and an egg depository are all factors favouring the lung worms.

In the struggle for existence, parasites persist where conditions favour them most. The sheep has so much to offer, that no less than fifty-eight different parasites consider the sheep their home. The susceptibility of the sheep is so great and the parasitic menace so widespread, that very few lambs escape their assault, and must pay the price in terms of lost blood, lost food, intense irritation and toxemia. Factors that make miserable runty lambs, and defeat the good breeding practices and good feeding of the most skillful flock masters.

Protecting the Flock.

The first duty of ownership is protection. An understanding of the life history of each parasite is invaluable to the sheep owner if he is to do his part in properly caring for his animals. Pastures become heavily seeded with worm eggs and young worm larvae, due to the fact that all eggs and larvae must pass from the body of the host animal, with the natural discharges. Eggs and larvae do not complete the life cycle in the host animal in which they were released by their parent, but must reach the outside and come under the influence of a temperature lower than that of the host animal. Conditions of moisture must also be favourable if the development of the hatching worm egg is to take place. The common knowledge that hill land is the safest sheep pasturage is explained by the fact that the lower lands offer better conditions for worm egg or larval development, than do the hillsides, which are washed free of contamination with every storm. The dampness of the valleys and the heavy vegetation favour the young worm, in that they afford protection from the wind and sun. The surface run-off of water from the hills carries with it the worm eggs deposited, with the natural discharges from the sheep, as they graze the higher ground, this tends to concentrate parasitic troubles on the low areas. Any field with water pools all the time, or only after rains, is an aid to bringing the lambs and parasites together, because the worm eggs or larvae may be washed into such pools, contaminate the water and thereby infest the sheep or lamb taking a drink therefrom. Creeks of running water, or troughs well above the ground surface are to be preferred as suitable places from which the sheep may obtain their water needs. The menace of the old pasture lot, laneways, yards near buildings where sheep have been running for generations, is not generally recognized by sheep owners. The soil surface and grass blades of such places are heavily infested with the young worms or vermiform eggs of whatever internal parasites the sheep or lambs may be carrying. The sheep, with its cleft lip, grazes close, the latterly placed eyes do not permit it to see the exact spot from which it is cropping the grass. The worm eggs and worm larvae are too minute to be seen, so the sheep is apt to pick up more than grass while feeding. Many encysted larvae on grass or in the bodies of beetles or flies, go the same route that the grass takes when it enters the sheep's mouth. The route to the stomach, the intestine and the lungs is short for the parasite that is stealing its way.

Give the lamb a chance by allowing it to graze on land free from contamination of the droppings of wormy sheep. On the Western ranges, where sheep start from the home ranch winter feed lots, in the spring and move steadily forward each day, passing over new ground, leaving their body discharges behind, less trouble from parasitism is experienced than in the East, where sheep are compelled to feed over the same ground again and again. Pollution comes quickly, one sheep heavily infested with stomach worms will distribute in her discharges not less than 3,000,000 worm eggs each day, each pellet or feces may contain as many as 6,000 eggs of this one species, thousands of others may be present. This will indicate the necessity for frequent change of grazing ground, the resting of old pasture areas for a year, the use of forage crops on recently plowed land, the use of a folding system or the use of a dry lot method of rearing lambs, the use of such vermifuges as will destroy all worms carried by the sheep, and the use of care and judgement in the purchase of either breeding or feeding sheep. The most severe infestations occur in warm, wet seasons when conditions favour the larval existence of the parasites.

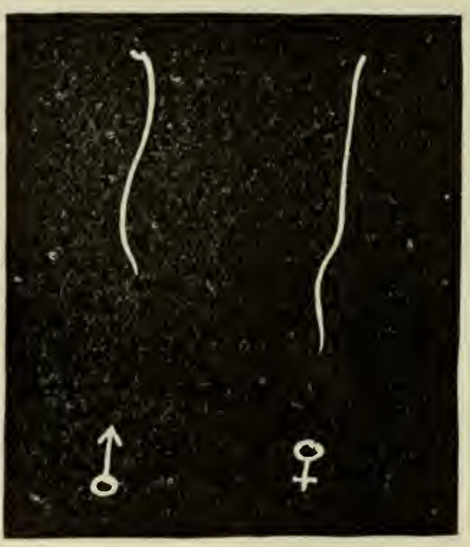


I.—Dung pellets, contain thousands of Worm Eggs.
II.—Worm Eggs hatch, young worms crawl up grass blades.
The infection is on the grass, of old pastures, and fields where wormy sheep are grazing.
Keep the flock moving ahead of infection.

INJURIOUS PARASITES.

The Stomach Worm, (*Haemonchus contortus*).

Description—A white thread-like worm, about the size of a pin, males one-half to five-eights of an inch long. The females are three-quarers to one and a quarter inches long, they are spirally striped, red and white, or may be all white, depending on the presence or absence of blood in the intestine. The males may also have the intestine coloured red, but do not show the striping characteristic of the female. The vulva of the female is near the posterior end of the body. The posterior end of the male is expanded and two-lobed. The head is armed. This worm is found in the fourth compartment of the stomach and also in the small intestine. It is a blood sucker with a bad reputation, for poisoning its host with toxic excretions, injuring the mucous membrane, and robbing blood.



Male and Female
Stomach Worm.

Life History—There are three stages in the life history of the Stomach Worm of sheep, the early or egg to larvae, the larval stage, and the adult stage.

The egg to larvae stage commences with the discharge of the egg from the uterus of the female, resident in the abomasum of an infested sheep. On release the egg passes along with the injesta, through the intestines, and is eventually thrown out, with the undigested food residue, undergoing but slight change during the journey. On reaching the soil, if the temperature and moisture are favourable to its incubation, a tiny worm will be released in a few hours. This embryonic worm feeds and grows in the fecal material for three or four days, reaching larval maturity, providing the environment remains favourable. With varying conditions of temperature and moisture the larval growth may be long delayed or even destroyed as at this time the little worm is a very delicate creature. After reaching larval maturity the little worm is protected by a chitinous sheath, and can then stand rough weather for long periods. The mature larval stage is spent on blades of grass, or on particles of manure or soil. Moisture is favourable to its movement, so many succeed in making their way up blades of grass, where they await the coming of a sheep or lamb. The adult or reproductive stage is spent in the abomasum of an infested sheep or lamb. The grass on which stomach worm larvae have successfully attached themselves is taken into the sheep's stomach in the usual course of feeding. The protective chitinous coat is dissolved off by the stomach juices of the sheep, and the little worm liberated, it at once attaches itself to the mucous membrane of the stomach wall, taps a food supply and grows to maturity in 14 to 21 days. The two sexes mate and egg production goes on apace, that more Stomach Worms may be created to infest more sheep and lambs.

Group of four lambs.

Distribution—The Stomach Worm is found wherever sheep are bred in Eastern Canada. This is true for the rest of the sheep-raising districts of the world. Very few flocks are free from the pest, which is unfortunate, when its eradication is not a difficult process on well organized sheep farms. Infective pastures have been found to remain infective to sheep for ten months, so at least a full year's rest from grazing with sheep is necessary to permit a pasture to clean up. Deep plowing of infective pastures has proven effective in rendering areas safe, for the production of forage crops that are to be grazed off by sheep or lambs. Ponds and pools of stagnant water, located in old pasture areas, over which sheep have been grazing, have been found to contain mature stomach worm larvae.

Symptoms—Diarrohea is a is a symptom of Stomach Worm Infestation.

The first symptom usually noted with sheep and lambs infested with Stomach Worms, is the runty, poor condition and light weight of the lambs in the flock. The older sheep will be correspondingly scrubby, nearly all will show a catarrhal conditions of the bowels, as evidenced by soft or mucous coated feces, and a dirty hind end. The flock is dejected looking and unthrifty. Old cases or very severe infestation is characterized by anaemia, which is due to the blood sucking habit of the worm. This is shown in the paleness of the skin and visible mucous membranes. Swellings appear on the lower jaw, lips and brisket in severe cases that are nearing their end. After death, if the fourth compartment of the stomach is opened the worms may be seen attached to the mucous membrane, or free in contact with the wall or floating in the liquid injesta. The mucous surface of the abomasum will show the punctures, where the worms have been attached during their blood sucking activity. The Stomach Worm is very small and may be easily overlooked by the inexperienced observer.

Treatment—Treatment is best administered by a competent veterinarian. A satisfactory remedy, that is efficient and safe, can be made by dissolving 4 ounces of Copper Sulphate in two quarts of hot water, then adding 4 ounces of mustard, then add two gallons more water, to bring the total quantity up to two and a half Imperial gallons of mixture. This quantity is enough for 100 sheep, treating once and allowing for waste. The dose of this Copper Sulphate-Mustard Drench is as follows:

For adult sheep use from 3 to 4 ounces.
For lambs 2 to 6 months old use from 1 to 1½ fluid ounces.
For lambs 6 to 10 months old use from 1½ to 2 fluid ounces.
For lambs 10 to 12 months old use from 2 to 2½ fluid ounces.

Measure accurately, and keep well mixed. Starve sheep for at least 18 hours before giving drench, and do not feed or water for at least 4 hours after drenching. This is important, as it gives the stomach time to clear before the vermifuge is placed to do its work.

Other remedies against Stomach Worm are as follows:

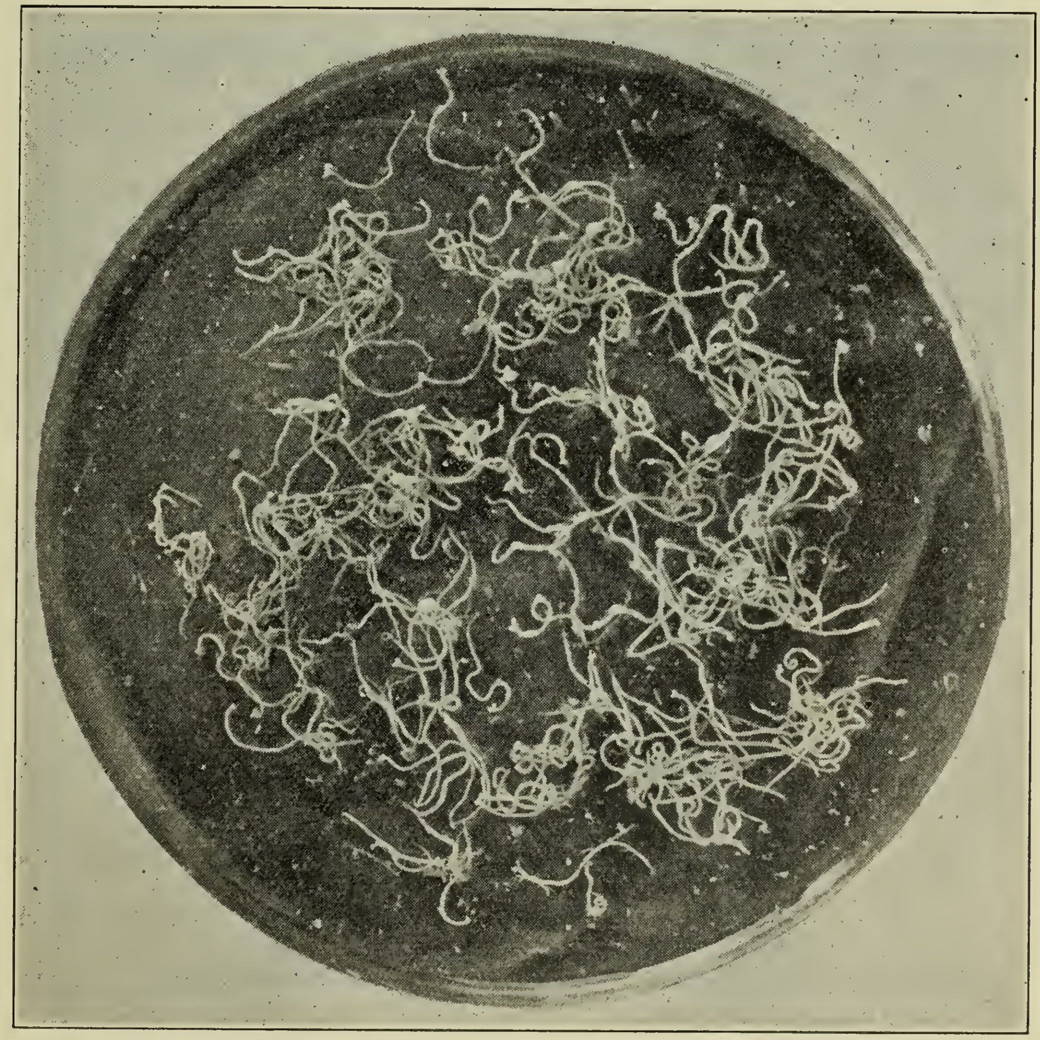
Tetrachlorethylene, given in capsule, is efficient and safe.

Tablets, containing copper sulphate, tobacco, and sodium arsenite, are also used with success.

Carbon-tetrachloride and Epsom salts, given in capsule, has a high efficiency against Stomach Worm.

These remedies generally require skilled hands for their administration, and the employment of a modern competent veterinarian is always advised. For those sheep men in the back districts, where veterinary service of high grade is not available, the following suggestions regarding drenching are given: Keep the sheep on its feet, use a small necked bottle, or fit a metal tube to a nursing bottle that is marked off in ounces, measure the dose accurately, do not raise the sheep's mouth above the level of its eye, nor raise the head too high, give it time to swallow, treat gently and have the other sheep in sight close by. Dosing sheep that have not been starved for 18 hours is just waste of time and material. Lambs two months old can be drenched with the Copper Sulphate-Mustard drench. Lambs should be separated from the ewes for six hours before being dosed, and not allowed back with the ewes after drenching, until two hours have passed.

Prevention—If possible use pastures on alternate years. Keep the young lambs off the old pasture areas, as lanes, grass areas around the buildings that sheep have been running over for years. Grow forage crops for the sheep and lambs to graze off. Such crops as Sweet Clover, Dwarf Essex Rape, Soy Beans and other tall growing plants, keep the sheep feeding high up above the soil surface, where the larval worms are most abundant. Each plowing turns under a lot of trouble. The use of the folding system, as practiced in England, is a very great help, as the sheep are moved to new ground before the worm eggs have developed to the encysted larval stage. Feeding from racks and watering from troughs well above the ground surface is always advised. Read the paragraph "Protecting the Flock."

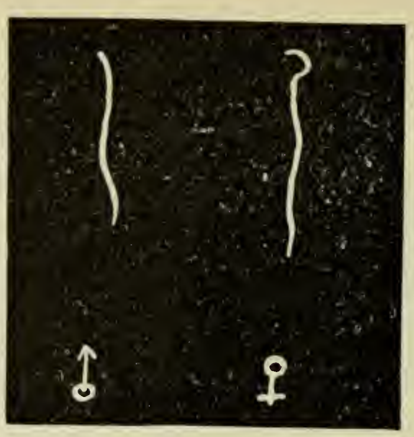


Stomach Worms as taken from a lamb. (Natural size.)

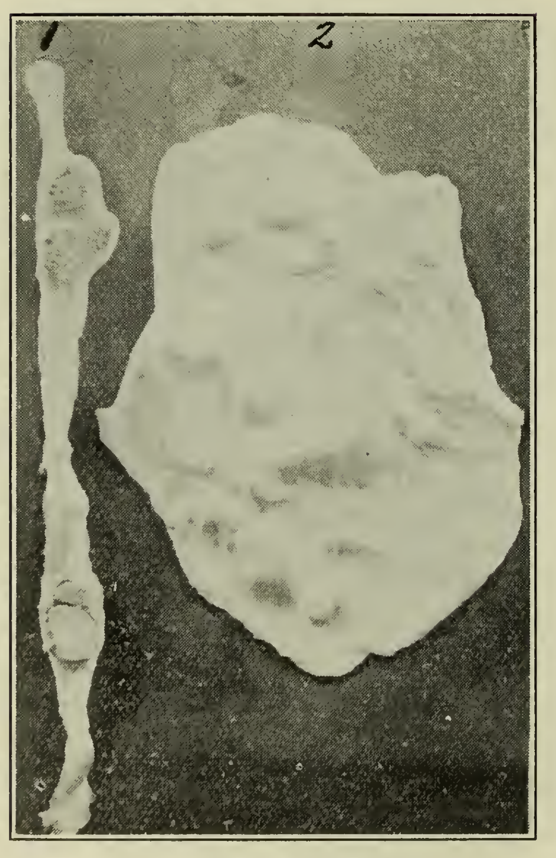
THE NODULAR WORM, (*Œsophagostomum Columbianum*).

Description—A small thread like worm, males about one-half inch long, females five-eighths of an inch long. The head end of the female is bent and resembles a hook in outline.

Life History—The life history of this worm can be divided into three stages, viz., the egg to larval, larval and mature. The egg to larval stage begins with the deposition of eggs by the adult female worm, resident in the large intestine of the host sheep. The eggs once free in the intestine



Male and Female
Nodular Worm.

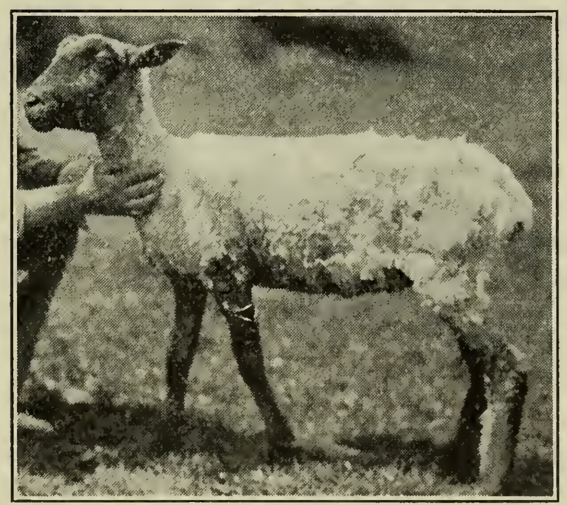


Larval Nodular Worm Lesions on Intestine.

1. Cross section of Nodules in wall of large intestine.
2. Nodules showing on the inner surface of large intestine (reduced).

of the sheep are carried along with the food residues and eventually reach the soil in the dung pellets. Under favourable conditions of moisture the eggs hatch within 24 hours, liberating the young larvae. These recently hatched larvae feed on the fecal matter surrounding them, go through two moults in about four days and become infective if weather conditions are favourable. The infective larvae gain entrance to the alimentary tract of the host, while the sheep or lamb is grazing, it may be on the grass, on the soil over which the sheep is nosing in her attempts to bite close, or in the water of shallow pools. Young lambs probably become infested through nosing around and sucking teats that have been in contact with contaminated soil. The infective larvae are carried to the large intestine with the injesta, being relieved of their protective covering on the way. Once free they penetrate the mucous membrane, and migrate aimlessly in the underlying sub-mucosa, finally coming to rest at a point suitable to their further development. Wherever the larvae rest a cyst forms, at first watery, then a dirty yellow colour, and finally a hard greenish yellow, cheese like or gritty mass has developed, causing the nodular appearance of the intestinal wall. The young larvae lives in the cyst for a period varying from a week to several months, before again entering the lumen of the intestine. Many larvae perish in their nodules. At the time of the second entrance into the intestinal lumen, the larvae may be as long as one-eighth of an inch, and are ready to develop to maturity quickly, which they do in about two weeks if conditions are satisfactory for normal growth. On reaching maturity, they pair and provide for the next generation. The length of life has not been determined, it probably varies considerably as a wide range of conditions exist in the host animals. These worms are principally found as adults in the large intestine, while as encysted larvae they may be in the small intestine, the large intestine or in the rumen.

Distribution—The Nodular Worm is very widely distributed in Eastern Canada, so much so that but 80 per cent. of the lambs slaughtered before they are eight months old, yield a small intestine, free enough of nodules to be used for sausage casing. Lambs over eight months old, yearlings and aged sheep are generally so extensively infested that the intestine cannot be used. As a result of this Nodular Worm damage Canada imports over a million dollars worth of sausage casing each year.



Sheep that look like this are heavily infested with Nodular Worms.

The durability of the Nodular Worm egg and larvae is not as marked as it is with the Stomach Worm, as the weather conditions experienced in winter apparently cause their destruction, when the Stomach Worm larvae survive. However the Nodular Warm has a way of continuing, in that its mature larval form is spent in the protective cyst, in the intestinal wall of its host, free from frost dangers. It winters over in comfort, developing ready to produce more eggs and infect more pastures when the sheep go out to graze.

Symptoms—Lambs or sheep with a light or moderate infestation of Nodular Worm, may show no symptoms discernable to the ordinary observer. And since most of the sheep of the country are infested with two or more internal parasites, it is difficult to attach the responsibility for the symptoms of disease manifested. However it is definitely known that Nodular Worm can bring about a condition of general debility, with marked emaciation and anaemia, and so weaken the intestine with its nodules that rupture is easy. Numerous sudden deaths in the flock during the grazing season, with no apparent illness of the sheep, may be attributed to intestinal rupture followed by peritonitis. The reduction of the intestinal surface, by the destructive presence of many irritating toxin containing nodules must have a very detrimental influence on the well being of the sheep. The nodules are widely distributed over the tract, may become as large as a hazel nut, hard and gritty, or contain a cheese like greenish pus.

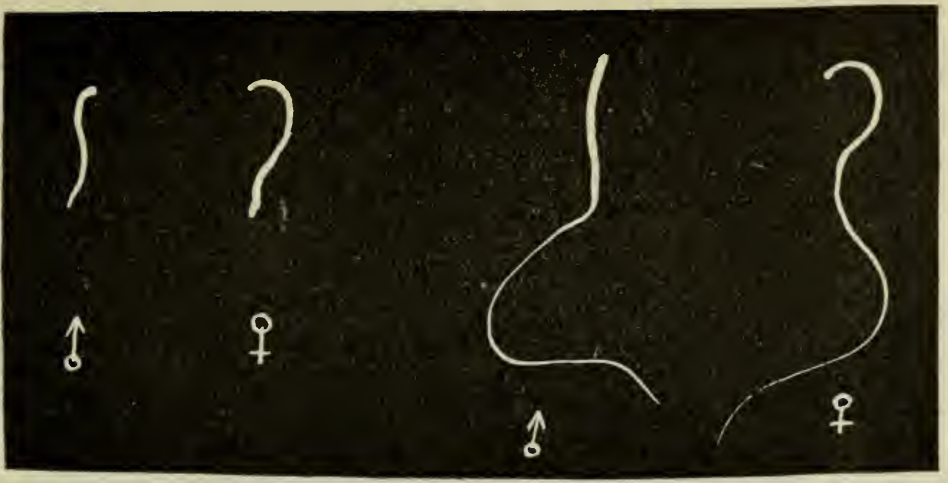
Treatment—The mature Nodular Worms in the large intestines are difficult to reach, this is also true of the larvae protected in the nodule. No medicinal treatment has been developed that is sufficiently practical for application on the ordinary farm flock. The repeated use of carbon-tetrachloride has been reported as being partly successful. The use of medicated enemas, and such drugs as will cause rapid clearing of the large intestine, might be worth while on valuable sheep.

Prevention—Raise a flock of ewe lambs, free from Nodular Worm as a nucleus for a new flock. This can be done under the following system. Breed the ewes to lamb as early as possible. Keep the ewes and their lambs in a clean dry pen, feed from racks and take such precautions as will prevent the lambs feeding from a dung soiled floor. When the grass season comes do not let the lambs run out with the ewes, but keep them in a clean pen. Provide another pen adjoining in which the lambs and ewes can meet at milking time, and allow them together for this short period only, sending the ewes back to their pasture and the lambs back to their own clean pen. Wean the lambs when they are four months old and give such additional feed as needed to keep them thriving. When the weaning is over the lambs can go out on grass on which no sheep has been for at least a year, or better on a plot of forage crop that has been grown specially for them, raise them entirely separate from the rest of the flock. The success of this method depends upon the thoroughness with which it is carried out, one day of neglect will spoil it all. With the new flock of lambs, to start with, it is advisable to get rid of all other sheep as soon as possible, and avoid the old pastures and yards for a year. Raise a ram lamb as a flock header in the same way, don't buy one from a flock that is riddled with Nodular Worm.

In handling the flock during the grazing season, aim to keep the sheep moving ahead of their own droppings, by changing grazing ground as frequently as the farm plans will permit. The use of crops grown on plowed ground, as alfalfa, sweet clover, soy beans, corn or rape, all tall crops that are browsed, are doubly valuable as such do not require the sheep or lamb to get its lips near the ground surface.

HOOK WORM OF SHEEP, (*Bunostomum trigonocephalum*).

Description—A small white worm, the female is one inch or less in length, the males are from one-half to five-eighths of an inch long, mouth of both sexes armed, posterior extremity of male expanded.



Male and Female
Hook Worm.

Male and Female
Whip Worm.

Life History—The mature Hook Worm is generally found in the upper portion of the small intestine, attached to the mucous membrane. The eggs produced by the sexually mature females pass on with the injesta and are eventually discharged with the feces. Under favourable conditions of temperature and moisture the egg hatches while in the dung pellet, the little worm feeds and goes through two moults, reaching the infective stage as a very small larval worm. These small larval worms live on or in moist surface soil, and gain entrance to the sheep's body while the animal is lying down on infected soil. After penetrating the skin the little larval worm reaches a blood vessel and is carried to the heart and lungs of its victim, leaving the lungs it passes by way of the trachea to the mouth and is swallowed, finally reaching the intestine, where it attaches itself and grows to maturity.

Distribution—The Hook Worm of sheep is not very common in Eastern Canada, and its centres for distribution have been largely from sheep imported from Great Britain and the United States. The ability of the eggs and larval worms to withstand the climatic conditions experienced during the Ontario winter has not been determined.

Symptoms—In general, the symptoms of Hook Worm infestation are similar to those caused by the presence of Stomach Worm, and an autopsy is the best way of determining which parasite is present. Sometimes both are found. The Hookworm is a blood sucker, that shifts its position frequently, leaving telltale small hemorrhages or red spots to mark the point of its destructive blood robbing. The blood of the victim is impoverished, nutrition is interfered with, animals become anaemic, weak, unthrifty; lambs do not grow, watery swellings may appear on the under portion of the body, skin pale, wool dry and poor.

Treatment—The Copper Sulphate-Mustard drench, as outlined for Stomach Worm has some efficiency against Hook Worm, and where repeated will clear them out. Frequent changes of pasture and strict hygenic measures are of the utmost importance in dealing with Hook Worm.

THE WHIP WORM OF SHEEP, (*Trichuris ovis*).

Description—A small white worm with stout posterior body and a long thin hair like anterior or head end. The two sexes are about the same length, ranging from two to three inches or over, the body shape varies somewhat in that the posterior body of the male is longer than that of the female.

Life History—The adult male and female reside in the cecum portion of the small intestine, where they are firmly attached to the mucosa by the thin hair like anterior end. Eggs pass from the infested intestine with the feces, and become vermiform under favourable conditions. Sheep or lambs become infested by taking up the infective eggs while grazing close to the soil surface or when drinking from shallow pools. The vermiform egg on reaching the intestine liberates its larval worm, which when free bores into the mucosa, attaching the head end firmly, grows to maturity, becomes sexually mature and produces more eggs to infest more lambs.

Distribution—The Whip Worm of Sheep is found in all sections of Canada, in flocks where sheep are poorly cared for. Evidence of its presence is not often seen in well managed flocks. The resistance of the eggs of this worm to winter conditions in Ontario has not been determined. The presence of Whip Worms in large numbers in the large intestines of lambs reared on old pastures has been noted.

Treatment and Prevention—Sanitation, as recommend for the control of Stomach Worm, is equally effective against Whip Worm. Sheep that are permitted to feed over large areas, or are given frequent changes from permanent pasture to forage crops, or run on pastures that are used for sheep every second year, require no medicinal treatment for this parasite. Other sheep, if infected, should be given carbon-tetrachloride by a competent veterinarian.

TAPE WORMS, (*Moniezias*).

Three species of Tape Worm commonly occur in sheep in Ontario, the *Moniezia expansa,* the *Monieia alba,* and the *Moniezia planissima.* Of these the Moniezia expansa is by far the most frequently seen. Some sheep imported from the Western Provinces may carry the Fringed Tape Worm (*Thysanosoma actinioidies*).

D*escription* (*Moniezia expansa*)—Head small and pear shaped, suckers projecting and slit like, segements broader than long, may reach the width of half an inch in sheep. This worm is generally not over eight feet in length when removed, but may be much longer.

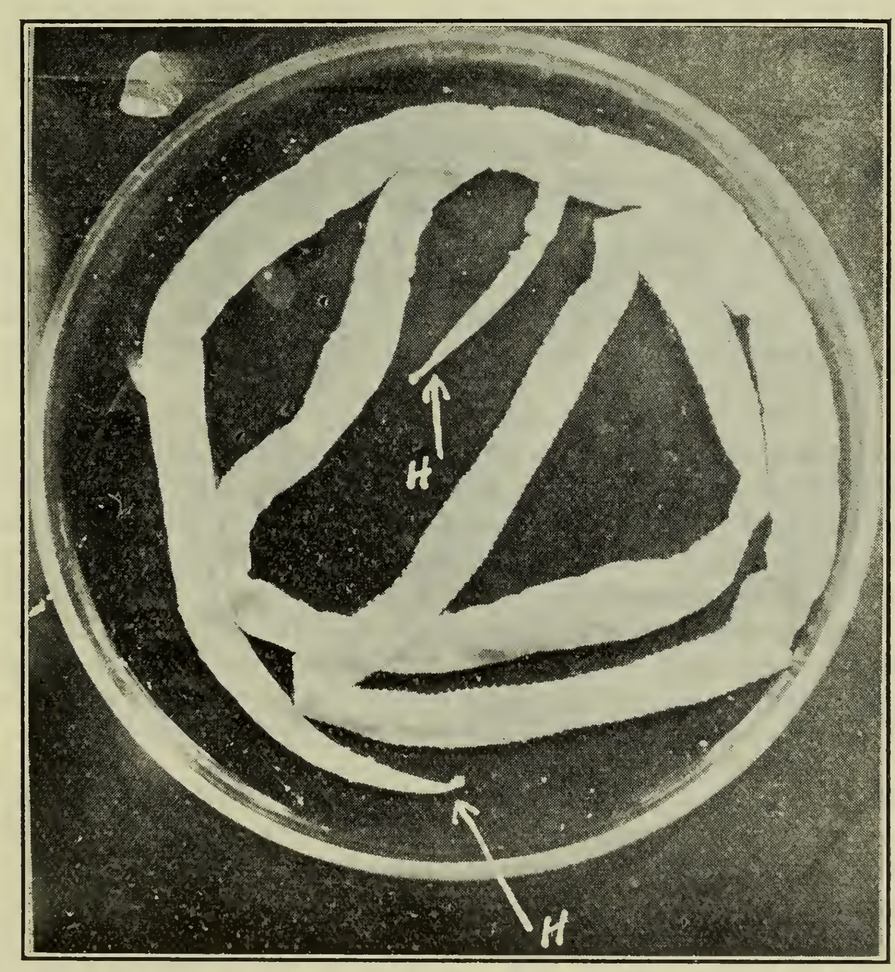
Moniezia alba—Head small with oval attachment discs, segments nearly as long as broad, may reach the width of three-eighths of an inch. This worm is generally under five feet in length when removed, but may attain a greater length.

Moniezia planissima—Head small, nearly square in outline, attachment discs elongated, segments broad and short, may attain a width of one-half inch or more. The length of this worm is generally not over three feet.

Thysanosoma actiniodies—Head is small and free of hooks or rostellum, the segments are broader than long with the posterior edge fringed. This is a small Western Tape Worm uncommon in Ontario.

Distribution—Tape Worm infestation is quite common, very few flocks escape. The injury done by Tape Worms, while serious, is not to be compared to the losses caused by Stomach Worm or Lung Worm. Poorly cared for flocks may have fifty per cent. of their numbers carrying Tape Worm.

Symptoms—Flocks in which runty, pot-bellied, anaemic looking lambs appear shortly after going to grass, usually prove on examination to be heavily infested with Tape Worms. Segments of Tape Worm are frequently seen on the feces of infected sheep, giving a clue to the presence of the worm. Sheep become unthrifty, weak and emaciated, have difficulty in living from one pasture season to the next, show a diarroheal condition in early and mid stages of infection, with constipation in advanced state of Tape Worm development. Intestinal obstruction through the release of large pieces of Tape Worm may result fatally.



MONIEZIAS OF SHEEP.

The heads and a small part of two specimens of tapeworm. Variety "*Moneiza expansa.*" H=heads. Note segments much broader than they are long.

Treatment—A number of drugs have been credited with high efficiency against Tape Worm, but for all practical purposes the Copper Sulphate-Mustard treatment, as given for Stomach Worm, will if repeated clear out the Tape Worm.

Oil of Chenopodium and Castor Oil are used with high efficiency, as is also Oleo resin of Male Fern. These agents should be administered by a competent veterinarian. There is no effective treatment against the Fringed Tape Worm.

OTHER TAPE WORMS.

The three species of Moniezias and the Fringed Tape Worm are the only Tape Worms likely to be found in their primary stage in the intestines of the sheep of Ontario. But there are four other Tape Worm species for which the Ontario sheep is a secondary host. These are as follows: *Taenia hydatigena, Taenia ovis, Taenia coenurus, Echinococcus granulosus.* These four species of Tape Worm spend their primary life in the intestine of the dog. Since they spend their secondary or larval life in the tissues of the sheep, considerable damage results from them each year. A brief description follows:

Taenia hydatigena—Is the adult form in the dog, that is responsible for the production of the eggs that develop into the Thin Necked Bladder Worms that are found attached to the mesenteries, omenta, or liver of the sheep. A few of these Bladder Worms may not cause very much trouble, but if a sheep picks up while grazing the number of eggs contained in one segment of the *Taenia hydatigena,* as dropped by the dog running over the pasture, the resulting infestation will surely kill the sheep.

Taenia ovis—This Tape Worm also lives its adult life in the intestine of the dog, and is responsible for the condition known as "measly mutton." The eggs of this Tape Worm passed from the intestinal tract of the dog, contaminate pasture grass and water supply of the sheep's grazing ground. The eggs are taken up by the sheep in drinking and grazing, the larvae leaves its protective shell in the intestine, it then penetrates the intestinal wall and eventually comes to rest in the muscle tissue, where a cyst forms around it. The cysts are about the size of a grain of wheat and contain the head and neck of the new Tape Worm.

Taenia coenurus—This is also a dog Tape Worm, the embryo form of which causes the condition in sheep known as Gid. Sheep grazing over ground contaminated by dogs, infested with *Taenia coenurus,* will pick up the eggs on grass or in drinking from shallow pools. The dissolving effect of the stomach and intestinal juices on the egg causes the release of the embryo, which cuts its way through the intestinal mucosa, and enters the blood stream to be carried to the brain and other tissues. The surface of the brain is suited to its development. Here the embryo worm wanders for a time before settling down to complete its growth into a large Bladder Worm. This takes about eight months. The irritation and pressure caused by the Bladder Worm during its period of growth bring about the following symptoms, provided the sheep lives: The sheep infected are restless, always moving, may walk in circles, or with the head held high, or head carried low, gait swaying or stumbling, refuse feed and water, and sometimes the vision is much deranged. Sheep generally die in about nine months after picking up the infection. May to August is the season when infection takes place.

Echinococcus granulosus (*Hydratid Tape Worm*)—The adult Tape Worm infests both dog and man, living in the intestine during its primary stage. The secondary or embryo stage is spent generally in either the liver or lungs of the sheep, however, it may sometimes be found in other organs. In the sheep it occurs as a multiple Bladder Worm, may be quite small or very large, contains a clear fluid in which a brood capsule may be seen. The symptoms exhibited by a sheep infested with these multiple Bladder Worms are very indefinite and depend upon the location and size of the cysts. Generally the presence of the infestation is not known until revealed by autopsy.

Prevention against secondary forms of Tape Worms.

Sheep owners can and should protect the sheep from these larval forms of Tape Worm. The losses at the farm and at the abattoirs, where there is Government inspection, is considerable, to say nothing of the risk that human beings take in being associated with dogs that are infested, with the primary stage of the worm, or by using meat products that contain the secondary forms. Protection may be secured by observing the following:

1. Treating all dogs that frequent the pastures or sheep yards with a suitable vermifuge every three months.
2. Destruction and burnng of bodies of all dogs known to harbour the Hydatid Tape Worm.
3. Properly disposing of all sheep, or the offal of any sheep that die or are slaughtered on the premises. Sheep heads and viscera should be burned and not thrown out where dogs can get them.
4. Regulations for country slaughter houses, that will bring about a safe disposal of the offal of all sheep slaughtered therein.

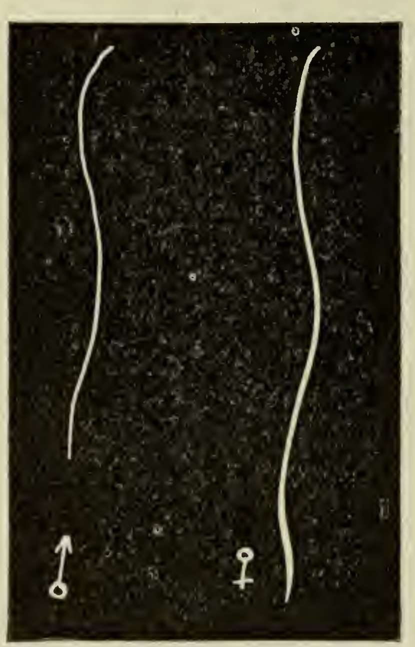
The neglect of ordinary sanitation by some stock owners is to be deplored. Animals dead, unburied or otherwise disposed of, left lying where dogs and birds can feed, are frequently the cause of the spread of parasites, disease producing bacteria and deadly toxins. When an animal dies dispose of it at once, that the parasites which it may harbour may be destroyed.

THREAD LUNG WORM, (*Dictyocaulus filaria*).

Description—A white thread like worm, that inhabits the air passages of the lungs, it is generally found near the extreme ends of the larger bronchi. The male worms vary from 1½ to 3 inches in length, the posterior end is slightly expanded, cleft and furnished with short thick spicules. The females are somewhat larger than the males, and may exceed three and a half inches in length, the posterior end is tapered, vulva located about mid-way of the body, and the intestine visible as a dark line for full length of the body. The eggs are large.

Life History—The mature female Thread Lung Worm releases her eggs in the air passages, where she is resident. These eggs contain visible embryonic worms when released. Many develop quickly and escape from the shell before leaving the trachea, others are slower in developing and may be found in various stages, in the mucous of the throat and nose, and also in the feces. The young worms and eggs are moved up and out of the trachea, to be coughed out on the ground, or swallowed, to pass back through the alimentary tract and out the tail end. On reaching the soil, with proper conditions of heat and moisture, the little larval worms moult and develop to the stage where they are infective to any sheep or lamb, taking them up in food and water. It takes about 10 days under favourable conditions from the time that the larvae or egg reaches the outside until it becomes infective. These lung worm larvae act much the same as do the stomach worm larvae, in that they make their way up grass blades and rest, to await the coming of a sheep or lamb. On being taken in by the grazing lamb, the larvae reaches the intestine with the food, it then penetrates the intestinal wall and enters a blood vessel. Once in the blood stream it is carried to the lungs where conditions for its development are favourable. It leaves the blood capillary in the lung and enters the alveoli and small bronchioles to grow to maturity in three or four weeks, it moves out into the larger air tubes as its increase in size demands. In five or six weeks after lambs have picked up infection, evidence of the presence of lung worm will be noted. Under Ontario conditions this is about the end of July.

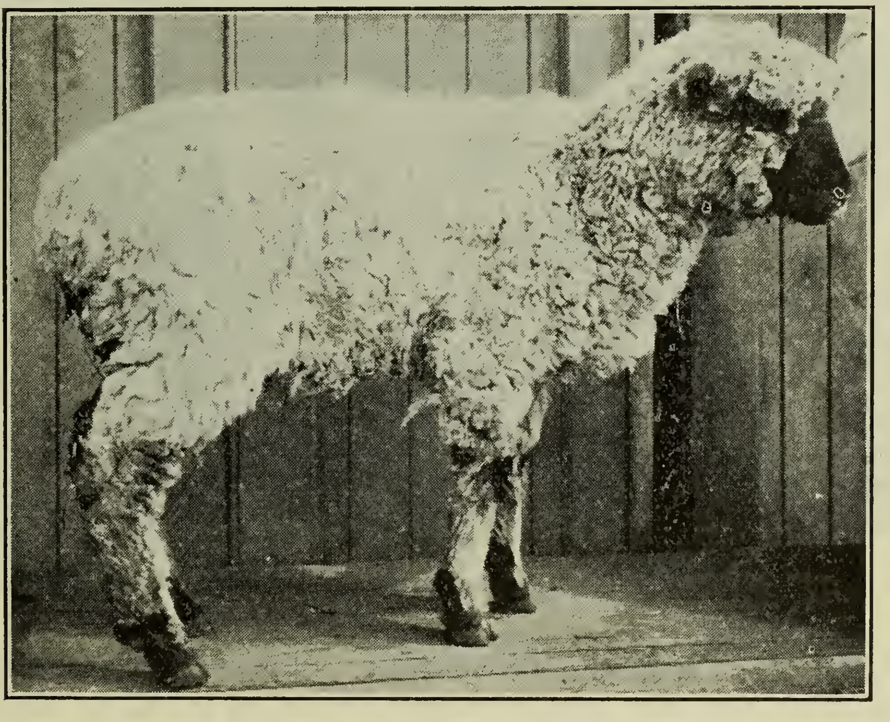
Distribution—The Thread Lung Worm is very common in Eastern Canada. Well managed small flocks suffer but little, but large flocks and flocks that continue on the same ground year after year, are apt to be heavily infested, particularly so if a "lung wormy ram" has been added to the flock during the past two or three years. It seems to take about that length of time for this parasite to make a wreck of a flock. The encysted larvae on grass is believed to be winter hardy in Ontario, old pastures will therefor remain infective for at least a year. The length of life for adult worms is in all probability in excess of six months, as numerous worms are found during post-mortem on sheep, conducted in March and April, after the animals have been off the land for five months.



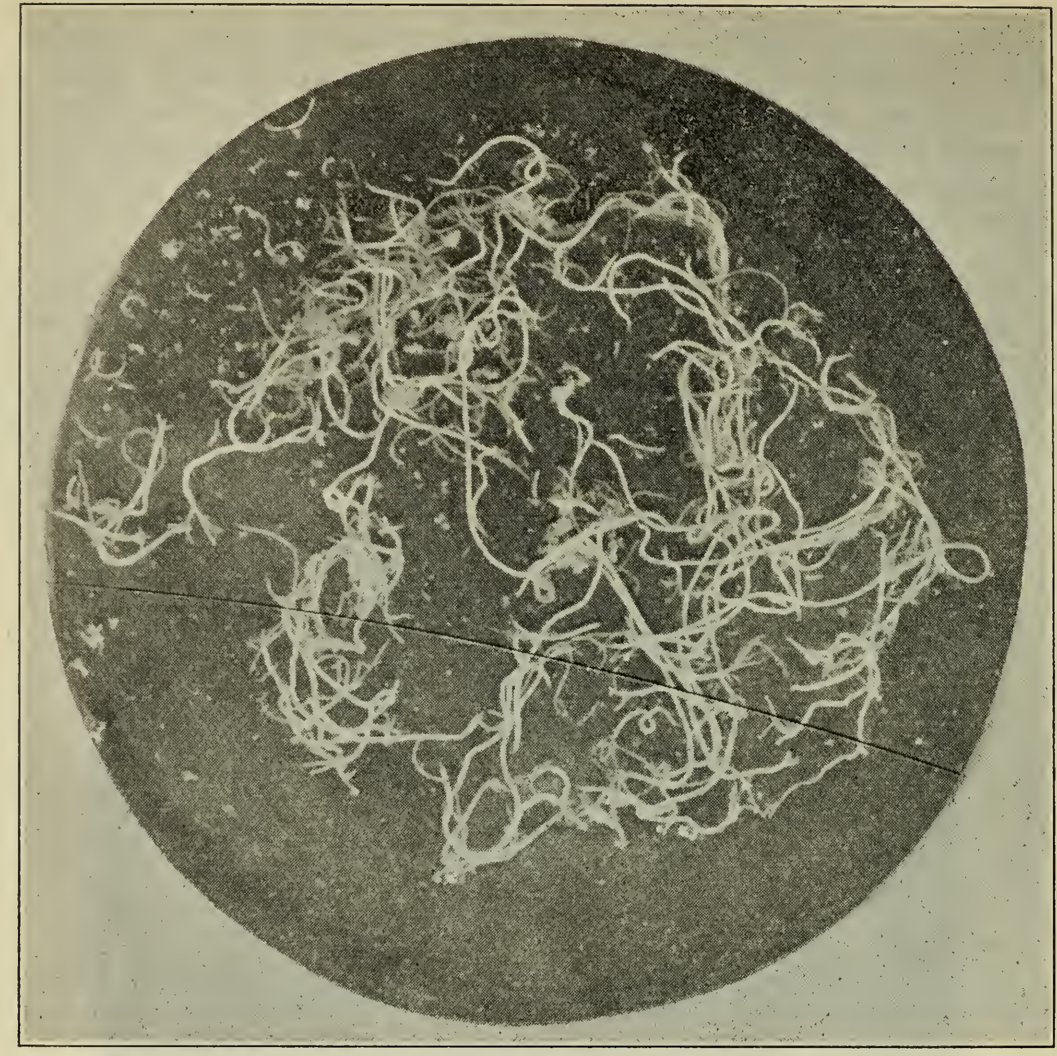
Male and Female
Thread Lung Worm.

Symptoms—The first symptom noted with lambs is that they slow up, stop growing in July or August. What were fine lambs in early June take on the characteristics of unthrift. In severe infestations, there is a condition of diarrohea, usually of the pasty yellowish type, a hacking cough, breathing not normal, rough wool, watery eyes, dirty brown crusted mucous on the nostrils, and a tucked up, forlorn appearance. Older sheep carry much the same symptoms, excepting the diarrohea. Lung wormy lambs are small, light, many lose their early weight and dwindle to the weight of a two months' old lamb when they are ten months old. Those that survive the wnter make small runty sheep and are never profitable. Post-mortem examination of a lung wormy lamb show the conditions of verminous bronchitis or pneumonia, much of the lung tissue is so altered that it cannot function. Post-mortem reveals the presence of the worms in the bronchi, and a microscopical examination of feces or a smear taken from the nostril or throat will reveal the presence of larvae or eggs.

Treatment and Prevention—Strict attention to hygiene, the use of upland pastures, and removing all individuals showing clinical symptoms of lung worm infestation is of the greatest importance. When the worms inhabiting the stomach and intestine are disposed of the sheep is in better shape to withstand the lung worm. So in treating for lung worm the disposal of all factors that are detrimental to the sheep's well being is the first step. Following this good care and medicinal treatment may be applied. The following treatments have been found to be useful in coping with this pest, causing the sheep to breath fumes that are irritant to the mucous membrane of the air passages, resulting in excess excretion and coughing, and spraying medications directly into the trachae. Such treatments should be applied by, or under the direction of a competent veterinarian. Treatment may result in death, if applied to individuals in which the lungs are largely congested or otherwise functionally destroyed. Such sheep are likely to die anyway, so treatment should not be witheld from the flock, as it can aid very greatly any sheep or lambs where lung destruction has not already gone too far. Early treatment during fair weather, when chances of penumonia or bronchitis are least is the best time (May to October). The change of pasture ground every ten days or less during June, July and August will help very much in keeping down infection. The use of tall growing plants as sweet clover, corn and soy beans, and rape, to keep the sheep from feeding on the surface of the



Five months' old lamb infested with tapeworms and four other varieties of parisites.



Thread Lung Worm as removed from the lungs of a sheep (natural size.)

ground is also a great aid in prevention. If your flock is now free from lung worm, then be very careful about bringing in other stock. Beware of sheep or lambs that have a cough (husky) or show any unthrift. If in doubt have a microscopical examination made of the feces and mucous from the nose or base of tongue, to determine the presence or absence of lung worm eggs or larvae.

HAIR LUNG WORM, (*Synthetocaulus rufescens*).

Description—A brownish-red, hair-like worm inhabiting the small bronchioles and tissue of the lungs of sheep. The males are about three-quarters of an inch long and the females up to an inch and a half. This worm co-operates closely with pathogenic bacteria, in that its ramifications make it possible for such to enter the lung tissue and gain lodgment.

Life History—Insofar as is known at present, the life history of the Hair Lung Worm is very similar to that of the Thread Lung Worm, described in the last section.

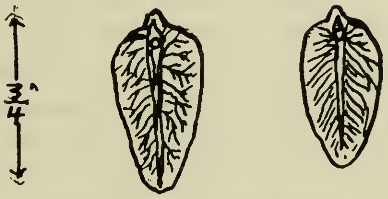
Distribution—In Eastern Canada, post-mortem examinations of sheep, reveal the presence of the hair lung worm less frequently than they do the presence of thread lung worm. However, its distribution is wide, and both varieties are found in the lungs of the same sheep quite frequently. The length of life for the Hair Lung Worm is believed to be the same as that enjoyed by the Thread Lung Worm, as worms in robust condition are found in April, these having in all probability developed from larvae picked up in October or November. The encysted larvae can stand winter conditions, pastures remaining infective from season to season.

Symptoms—The symptoms developed by infested sheep are similar to those exhibited in cases of Thread Lung Worm infestation, but the post-mortem examination shows a slightly different picture. This worm its larvae and eggs cause a localized pneumonia condition, distinguished by grayish yellow tumor-like areas, that vary in size up to three-quarters of an inch across, frequently very irregular in outline, and but slightly elevated above the surface of the neighbouring tissue.

Treatment and Prevention—The disposal of animals that are infested, and therefore act as spreaders, is of great importance. Frequent change of pasture, guarded water and food supply, will do much toward reducing the inroads made by this parasite. The use of medicines that are excreted through the lung-circulation have not been very successful to date.

Synthetocaulus capillaris—This lung worm is smaller than the two previously described. The females are hair-like, brown-red in colour and less than an inch long. The male is about half an inch long, with curled caudal extremity and small bursa. This lung worm spends the greater part of its life in the small air channels where it releases its eggs. When its life work is done, it bores into the lung tissue and becomes encapsulated. These nodules may be felt near the periphery of the infected lung, and vary in size from that of a millet seed to a smaal pea. Infestation takes place as with the Thread Lung Worm and the same hygenic measures of control apply equally to this parasite. Internal medications have not been, as yet, demonstrated as successful.

THE LIVER FLUKE, (*Fasciola hepatica*).



Liver Fluke of Sheep.

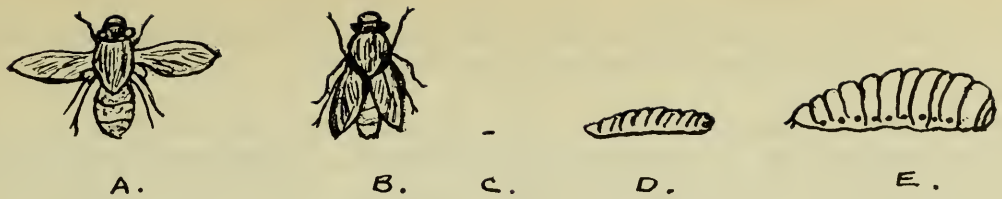
Description—The Liver Fluke of Sheep resembles in colour and surface a small piece of liver. It is a flattened, leaf-like, oval-shaped creature about an inch long, on its under surface at the head end, there is a conical process in which is located the mouth, surrounded by a sucker disc. A ventral sucker is located just posterior to the mouth, the body surface is covered with very minute spine-like processes, all of which point backwards from the head end. These spines make it possible for the fluke to hold its position or move forward in the bile ducts of the liver. The eggs of the Liver Fluke of Sheep are very large, round-oval in outline, coloured brown and provided with an operculum.

Life History—The adult flukes reside in the bile ducts of the liver, here they release their eggs, which are carried out with the bile to the gall bladder, and ultimately to the intestine, where they pass out with the feces. One Liver Fluke may produce 100,000 eggs. These eggs, under suitable conditions of temperature and abundant moisture, go through an embryo developing process and eventually release a small ciliated organism, capable if living for a short time in surface water. This organism is called a miracidium, and its life object is to find a snail (of the genus Limnaea), soft and juicy, into which it can penetrate. While in the snail it becomes a "sporocyst" or reproductive cyst containing from five to eight germ cells. These germ cells develop into "rediae," an organism capable of migration, which develops to a further stage known as "cercarie." One Fluke egg may result in the production of 150 "cercarie." The "cercarie" resembles a very small tadpole in outline, in that it is provided with a tail and can make use of such in swimming. At this stage it leaves the body of the snail and takes to a free life in the water, finally coming to rest on a blade of grass or aquatic plant, where it becomes encysted as a little white body, about one-sixteenth of an inch in diameter and circular in outline. In this position it remains, awaiting the coming of a grazing sheep. The grazing sheep takes up the encysted "cercarie" with the herbage, it passes back to the stomach and intestine, to be liberated. On liberation in the intestine it penetrates this structure to enter the abdominal cavity, where it wanders at large. This young fluke bores through the river capsule and enters a bile duct, migrating to the larger channels when forced on by growth. In the larger bile channels, the flukes live and prosper, going ahead with their life work; that of producing more eggs, which develop through the peculiar life cycle to form more flukes to destroy more sheep.

Distribution—The Liver Fluke of Sheep is, fortunately, a rare parasite in Ontario, due largely to the fact that sheep in this Province are kept on well drained, cleared lands that are relatively free from swamps and waterholes. Its presence in the Province has been limited very largely to sheep imported from other Provinces. As this pest depends upon the snail for its development, and since the encysted "cercarie" perish in the absence of moisture, Ontario conditions are not believed to be very favourable to its propagation.

Symptoms—Sheep heavily infested, will lose condition, as the invaded liver is destroyed or prevented from performing its various functions, the appetite becomes poor, the animal is listless, dejected, the respirations are feeble and quick, edematous swellings may appear under the jaw, the brisket, or belly, and a diarrcheal condition is usually present. Sheep may make fair recovery if the infestation is light and not too much liver tissue destroyed. A post-mortem examination of a fluke infested liver will reveal the following conditions: a soft or rotten condition, uneven or roughened surface, scar tissue areas, enlarged bile ducts and the presence of flukes.

Treatment and Prevention—Keep the sheep off areas where the fluke infection is known to be present. Drain wet or swampy pastures that harbour snails of the species Limnaea. Apply lime or salt to the infected area during June, July and August, the months when infection usually takes places. See that the water supply is safe. Should the damage done the sheep's liver have not advanced too far, the offending flukes may be destroyed, and the sheep's life saved, by administering Oleoresin of Male Fern, or a preparation known as Danistol. The diagnosis of liver fluke disease, and the administration of the mentioned drugs should be undertaken by a competent veterinarian only.



A. and B. Mature Flies. Oestrus Ovis. Sheep Bot Fly. C. Size of larva when deposited. D. Larva at 2 months. E. Larva at 8 months.

THE NOSTRIL FLY, (*Oestrus ovis*).

Description—The Sheep Nostril Fly is a little larger than the common stable fly, its head is yellowish, thorax brownish-grey, abdomen mottled and hairy, mouth parts undeveloped, wings (two) large and transparent.

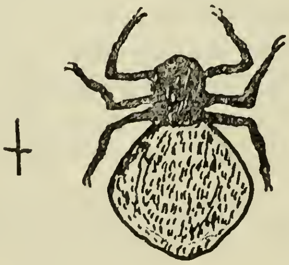
The grub or larvae of the Sheep Nostril Fly is yellowish white in colour and when full grown measures about three-quarters of an inch long and about one-third of an inch through, being composed of eleven or more segments. These larvae are provided with a strong pair of mandibles, that enable them to hold fast to the membrane lining the nasal sinuses.

Life History—With its mouth parts undeveloped, this fly cannot feed, so its life is not a long one. After leaving the soil where the final transformation from grub to mature fly took place, these flies seek a mate and pair with such while flying. The male, having fulfilled its life mission, dies, while the female, now pregnant with fertilized eggs, nourishes such in her body until the tiny larvae are liberated. In this advanced state of multiple pregnancy the female fly seeks a flock of sheep or lambs on which to unload her progeny. She does this by depositing the larvae on the edge of the sheep's nostril, one at a time, making frequent thrusts she may deposit as many as sixty on one sheep during the course of several hours. The young maggot crawls upward in the sheep's nostril, and finally comes to rest in some part of the nasal sinuses. At the end of migration the maggots settle down for eight or ten months, lving upon serum, mucous or purulent materials caused by the irritation of their presence. During their development over this long period in the nasal sinuses, they cause inflammation of the mucous membranes of these passages, resulting in a disagreeable discharge from the sheep's nose during winter and spring. When fully developed the grubs loosen their grip on the mucous membrane, and bathed in a coat of slippery purulent mucous are discharged by the head shaking and sneezing efforts of the sheep, falling to the ground. Once on the soil the grubs seek cover in the loose dust or soil and go through the last stage of their development, emerging in four to six weeks of time, as an adult two-winged fly. Some grubs never get out of the nasal sinuses alive, as they sometimes grow to be larger than the possible exit, these die, decompose and are thrown out with excretions.

Distribution—The Sheep Nostril Fy was introduced into Ontario with sheep imported from Great Britain many years ago. Its presence is quite common in all sheep districts of Eastern Canada during June, July and August, and anyone familiar with sheep will know when the fly is pestering them in its attempt to deposit its larvae. The fly during flight emits a peculiar buzzing note, which occasions great excitement in the flock, causing the sheep to crowd together with their heads down. If many flies are working, the sheep may run about, sneeze and rub their noses on forelegs or ground in attempt to offset the tickling caused by the movement of the recently deposited larvae.

Symptoms—The symptoms vary in degree according to the number of grubs present in the upper air passages. One grub will cause but little evidence of its presence, while twenty or more create so much inflammation that the condition of "snotty nose" soon develops and is long continued. The animal shakes its head, rubs its nose, its face may swell and it rapidly loses condition, while the irritation continues. During the early stages of inflammation caused by the irritating hooks and spines of the larvae the symptoms are those of a common cold (running nose, frequent sneezing), bacterial infection may follow this stage and there soon develops a severe catarrhal condition. The air passages are partly plugged, causing the breathing to be difficult, toxic materials are absorbed, the sheep is restless, and unthrifty. In severe infestations the animal may die.

Treatment and Prevention—Treatment applied to sheep infested with the larvae of the Sheep Nostril Fly have not been very successful. Some larvae can be dislodged if not too far back, but those far back in the nasal sinuses are in a very protected position. The trepining operation can be performed by a skilled veterinarian, but owing to cost, can only be applied to valuable pure bred sheep. The use of lime dust, sulphur fumes, benzine, eucalyptus, turpentine or other irritants that produce violent sneezing and stimulate heavy mucous secretion, give some relief to the infested sheep. Sheep running in bush pastures or fields where there are patches of scrub or brush into which they can retreat when the fly is about, largely escape its attentions. The fly must have open space in which to operate. Sheep running on bare fields can be protected fairly well by daubing their noses each week with pine tar during June, July and August. The plowing of furrows across the pasture field at intervals of 30 or 40 yards, to provide a place into which the sheep can dip her nose, to a position where the fly cannot dart in and deposit her little maggot, is a good practice. Salt or feed troughs can be so arranged, that the sheep will do its own nose tarring while taking salt or feed from a specially constructed trough. Such a trough can be made by boring three inch holes in a cedar log, fill these with salt, and then smear pine tar around the hole, frequently enough to keep it sticky and in good condition to mess up the sheep's nose.



Sheep Ked.

Pupa of Ked.

THE SHEEP KED, (*Melophagus ovinus*).

Description—A reddish-brown insect, that is one-quarter of an inch or more in length, and one-eighth of an inch across the abdomen. The body is hairy and the covering integument is chitinous. The head is furnished with blood-sucking mouth parts. Attached to the thorax there are three pairs of short strong legs, that are furnished with grasping claws. The abdomen is large and a short-oval in outline.

Life History—Seven or eight days after mating of the sexes, the female Ked gives birth to a living larvae, that is enshrouded in a soft whitish membrane. This covering membrane serves to stick the larvae to the wool, it changes colour, becoming a chestnut brown. In size and shape this newly deposited larvae resembles a seed of the garden raddish. The duration of pupation varies with seasonal conditions, in warm weather the emergence may take place in less than 20 days, or on the other hand during cold weather and on exposed sheep the period may be six weeks. The pupa may remain attached to the wool, as most of them do, or it may fall to the ground or floor of the pen, in either position development takes place if conditions are favourable. During the summer or short wool period, many pupa fall to the ground and the resulting young ked if it does not get back on to another sheep will perish. During the autumn and winter, or long wool period, pupa are not likely to fall off, hence nearly 100 per cent. will remain on the sheep to complete their development. This is one reason why Keds are more abundant during the winter than they are during the summer. Hence the supreme importance of autumn dipping. The adult female Ked produces a living larvae every nine days during her life-time, which is about four months. These larvae reaching sexual maturity and reproducing in about thirty days during the warm period, (longer during cold) result in the offspring one one pair of Keds reaching the number of 700 between May of this year and May of next year. From this you will see how important it is to destroy all Keds, by double dipping both spring and autumn.

Distribution—Sheep Keds are found wherever domestic sheep are kept. The life of the Ked is spent entirely on the sheep's body, with the exception of a few individuals that have fallen from the sheep as pupa. The Keds do not travel far as they are wingless and their legs do not favour long migrations. The migrations consist of transfer from ewe to lamb during contact. Keds removed from the sheep's body will not live for more than eight days. However, the pupa can live apart from the sheep for more than six weeks. Hence the necessity of keeping the recently dipped flock out of the pens used previous to dipping, for at least two months.

Damage—These insects cause great irritation to the sheep, and particularly to the tender skinned lamb. The Ked's proboscis penetrates the skin, this is painful and is accompanied by the injection of an irritating salivary secretion. Itchy reddened pimples appear at the points where the blood sucking has been done, these remain for 24 or more hours. With six Keds to the square inch over the sheep's body, as we frequently see, thrift is impossible and the animal falls easy prey to other parasites and bacterial diseases. The wool from sheep heavily infested with Keds is soiled and dirty, and of much lower value than the clean wool from the Ked-free sheep. Stains, excrement and broken pupal cases must be removed by washing and carding, this requires time and occasions much loss. The farmer that neglects to dip must take a lower price for his wool crop.

Treatment and Control—Sheep that are dipped in September and again after an interval of 24 days are, if the work has been thoroughly done, Ked free. Once free of Keds, care should be taken to prevent other sheep carrying Keds coming in contact with the flock. The breeding habits of Keds indicate that double dipping should be practiced, as the common dips used have no effect on the pupa. Hence the second dip, applied 24 days after the first, is for the destruction of any young Keds that have emerged in the interval. There are always some of these to keep the infestation going, and the second dipping is the only way to get them. The common practice of dipping once a year, while it helps very materially in giving the sheep and lambs relief, may leave some pupa on the sheep uninjured and the infestation continues. If but three pupa escape, a male and two females resulting, a Ked population of 1,200 or 1,400 may result by the time of the next dipping (annual). So be thorough and see that none escape. After dipping sheep should be kept away from yards and buildings previously occupied by them, for at least two months. This will give time for any young Keds that usually infest such premises to starve and die. Sheep pens and yards should be thoroughly cleaned out and sprayed with a strong disinfectant. People working with infested sheep should keep away from clean flocks, as the Ked can be easily carried from farm to farm at shearing or any other time.

Dips made from coal-tar creosote, lysol, cresol, creolin, nicotine sulphate, lime-sulphur-arsenic compounds, all give excellent results if properly used. Many commercial dips are offered that are highly efficient. These commercial dips as recommended by sheep club directors are generally more economical to use than dips made from purchased ingredients and made up on the farm. For those desiring to make up their own dip from materials that are always at hand on the farm, and do not cost very much, the following formulae are given:

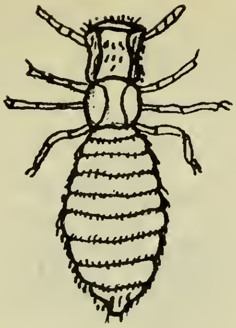
Milk Emulsion—To one part milk add two parts coal oil, mix thoroughly in an old churn or by forcing through spray pump. *To use* dilute this emulsion by adding eight gallons of warm soft water to one gallon of emulsion.

Soft Soap Emulsion—To make dissolve one pound of hard soap in two gallons of boiling water, remove from the stove and while very hot add two gallons of coal oil. Mix by forcing through a spray pump, or stirring and pouring. *To use* dilute this emulsion by adding one gallon to eight gallons of warm soft water.

Keds migrate from ewe to lamb, making life miserable for the lamb, unthrift follows. Unfortunately, the lambing season is the season of greatest Ked infestation, it is also a cold, wet period in Ontario, so dipping cannot well be done in March and early April, unless dry warm shelter is provided. The use of a powder that can be rubbed into the little fellow's wool, will give protection until the regular dipping can be done in May. Such a powder can be prepared by mixing the following:

Napthalene	One ounce, powdered.
Helabore	One ounce, powdered.
Sabadilla Seed	Three ounces powdered.
Borasic acid	Three ounces.
Tobacco dust	Three ounces.
Sulphur	Two ounces.

Apply with a shaker can or dust gun while wool is parted by an assistant.



Biting Louse .x 15.

BITING LICE, (*Trichodectes ovis*).

Description—The Biting Louse infesting sheep may be distinguished from the Sucking Louse (*Haematopinus ovillus*) and from the Foot Louse (*Linognathus pedalis*) by its head, which is as broad as long, and by the single row of hairs on each segment. The male Biting Louse is approximately one-twentieth of an inch long, the female slightly longer. The abdomen is white in colour and the head reddish.

Life History—The adult Biting Lice feed on the surface of the skin of sheep. The female releases her eggs, which in their sticky condition adhere to the wool, down close to the skin. The eggs hatch in five to ten days, according to temperature at the surface of the sheep's body, which varies. On sheep exposed to cold weather, the hatching period may exceed ten days. The young lice grow to maturity in about two weeks.

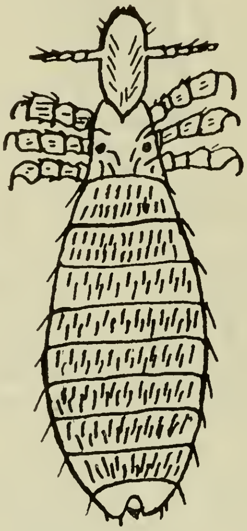
Distribution—Biting Lice of sheep are to be found in all poorly kept flocks. Any flock in which dipping has been neglected for a year or two will pay many times the price of the dip in losses caused by this louse. Pregnant ewes in neglected flocks abort their lambs and lose much of their wool due to this pest. During the short wool season, summer rains help keep the numbers down, but during the long wool season when the sheep are under cover the numbers of lice increase with great rapidity.

Treatment and Control—Any flock that is being regularly dipped, to control the Sheep Ked, is not likely to suffer from Biting Lice. The Sheep Dips recommended in previous section of this circular are effective against the Biting and all other lice. Sodium Flouride dusted through the wool is very effective against Biting Lice, and is a very useful remedy to apply during the late winter, when it is not practical to dip. Sodium Flouride must be kept away from the nose and eyes of the sheep. The quantity required is about one-half ounce per head.

SUCKING LICE, (*Haematopinus ovillus*).

Description—The Sucking Louse, infesting sheep, differs from the Biting Louse, in that it is much larger, and has a longer narrower head, and each segment of the abdomen has two rows of hairs. The female of this species is approximately one-tenth of an inch long, the male is slightly shorter, the abdomen and thorax are white.

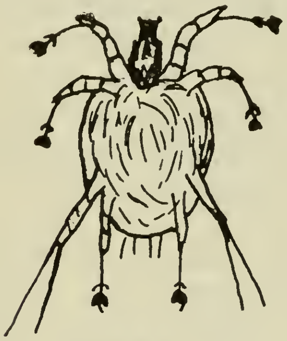
Life History—The adult Sucking Louse, feeds by tapping the skin and drawing blood from a vessel within reach. The female releases her eggs, which adhere to the wool fibres near the skin. The eggs incubate and release the young in from 10 to 18 days, according to environment. The young lice grow to sexual maturity in two weeks' time and provide for the next generation.



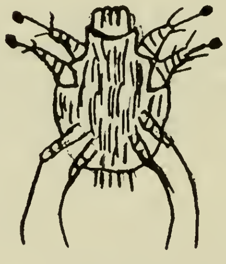
Sucking Louse .x 30.

Distribution—Sucking Lice are not very common in Ontario flocks.

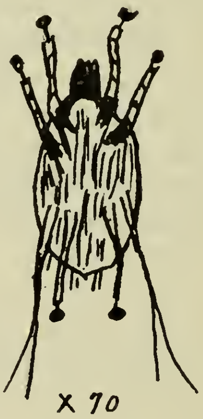
Treatment and Control—The use of dips, as for Keds, is effective against the Sucking Louse. See section on Treatment and Control of Keds. Heavy winter infestations may be controlled by the use of the dusting powder as recommended for Keds.



Sheep Scab Mite.



Head Mange Mite.



Foot Mange Mite.

MANGE MITES.

The Mange Mites, of which there are three varieties, cause but little damage in Ontario flocks. Only the poorly kept or neglected flocks showing any infestation.

The Mange Mite responsible for "Sheep Scab" and known as *Psoroptes communis ovis,* is not known to exist in Ontario at time of writing. The Sarcoptic and Symbiotic forms of mange mite confine their operations to the hairy areas of the head and legs. Severe irritation is caused by the presence of the two last named varieties, but the infested areas are usually small, and the pest is easily controlled by any contact remedy such as sulphur ointment, or a one per cent. solution of carbolic acid in linseed oil.

"SHEEP SCAB" MITE, (*Psoroptes communis ovis*).

Description—The males are one-fiftieth of an inch long and one-eightieth of an inch broad. The females are a little larger, both sexes are oval in outline, and are equipped with four pair of legs. The female has the first, second and fourth pair of legs, equipped with a sucker disc and numerous hairs, the third pair of legs terminate in two very long hairs. The male has each leg terminating in a sucker disc, which differs in its attachment from that of the female. These mites feed on the surface of the skin.

Life History—The adult female may produce any number of eggs up to twenty-five, or under certain conditions may give birth to nymphs. In event of eggs being deposited, which is generally the procedure, they hatch under favourable conditions in seven days or less, liberating a six-legged nymph. These nymphs feed for, three to six days, and then go through a moult, emerging as a mite, possessed of eight legs. In another three or four days they have grown to be about mature size and ready for a second moult, which generally brings them to sexual maturity. The sexes pair, following the last moult and reproduction is again provided for. The increase is rapid. Females may moult several times and produce a batcs of eggs or nymphs following each moult.

Symptoms—The Scab Mite favours the back, loins and rump of the sheep, but it may be found on any part of the body. Its presence is followed by an intense itching, sheep are noticed rubbing against trees, posts, fences or any object on which they can get relief. The lesions are small when first noticed, and if examined are found to be covered with a yellowish or yellowish-brown crust. The skin becomes scurfy. The areas increase in size, numbers may coalesce and form large irregular patches. The "Scab Mites" migrate to fresh skin as the older infested spots dry out and become bare, leaving a thickened wrinkled skin. The intense itchiness caused by the "Scab Mite" makes thrift impossible for the sheep, the wool becomes ragged due to scratching, the lambs are frequently aborted, or if carried full time get a very bad start.

Treatment—The presence of this "Scab Mite" in a district must be reported to the Federal Health of Animals Branch Inspector nearest at hand, or to the Veterinary Director General, Department of Agriculture, Ottawa. Control is by dipping the sheep in various fluids containing arsenic, sulphur or cresol. Dipping must be repeated in seven to fourteen days to be efficient.

THE HEAD MANGE MITE, (*Sarcoptes scabei ovis*).

Description—These mites are about half the size of the Psoroptes communis ovis, and are more nearly round in outline. They are equipped with four pair of legs. The first and second pair of legs terminate in a sucker disc on the end of a stalk, numerous hairs also adorn the legs. The third and fourth pair of legs terminate in a single long hair.

Life History—The female burrows into the surface layers of the sheep's skin, and deposits her eggs in galleries thus formed. The hatching and moulting of larvae requires about two weeks, this takes place in the burrows. When sexually mature the young mites come to the surface o fthe skin and copulate, following which the males die and the females seek location for a gallery and burrow into the skin.

Symptoms—The first symptoms are intense itching, which the sheep attempts to remove by rubbing against any fixed object. Small nodules form on the surface of the skin due to the burrowing habit of the female. Papules develop from the nodules, these rupture and leave the skin in a scaly crusted condition. The removal of the crusts reveals a red and raw surface. The areas become larger and the skin thickens with the extension of the scab area.

Treatment—The application of a light ointment, made by adding one part of ground flours of sulphur to eight parts Neatsfoot oil, will give relief if repeated in ten days.

FOOT MANGE, (*Chorioptes ovis*).

Description—This mite is somewhat smaller than the Sarcoptes scabei ovis, and also more oval in outline. The first, second and fourth pair of legs are equipped with sucker discs that are attached by very short stalks. The third pair of legs terminate with two very long hairs.

Symptoms—The feet and legs are attacked. The sheep may bite at the skin covering the legs, stamp their feet or rub the part irritated with the nose. The surface of the skin at the point of attack is bare and red, grey crusts form, these may become wart like. This mite usually attacks the area of the fetlock in sheep, and does not often spread above the hocks and knees. On the goat it may spread over the entire body, producing a heavy scaly condition.

Treatment—As recommended for Head Mange.

TICKS, (*Acarina*).

The true ticks, infesting sheep are distinguished from the so-called "Sheep Tick" or Ked, which is a very common and serious pest, by having many differences in body structure and life history. The common so-called "Sheep Tick" or Ked is an insect with six legs, while the true ticks are Arachnids with eight legs.

In the older settled sections of Ontario, where the sheep population is greatest, no injury to sheep from Arachnids is being reported, and such if present are in apparently very limited numbers. In the newer or rough bushy areas of the Province true ticks are present but not in sufficient numbers to cause very much damage.

The Wood Tick (*Dermacentor venustrus*) and the Elk Tick (*Dermacentor albipictus*) are the two species found in the wooded districts, and are reponsible for the condition "tick paralysis" in lambs.

SHEEP MAGGOT FLIES.

There are two species of flies responsible for considerable damage each year through causing the condition commonly known as "fly blown," "maggoty" or "struck." The two offenders are the Blow Fly and the Flesh Fly.

THE BLOW FLY (*Calliphora vomitoria*).

Description—In colour the abdomen is bluish green with a metallic lustre, the eyes are brown. In size this fly is a little larger than the common house fly, musca domestica.

THE FLESH FLY (*Sarcophaga sarraceniae*).

Description—In colour this fly is a light grey with black markings, very similar to those of the common house fly. The eyes are reddish-brown and the body is protected by stiff hairs which give the fly a spiny appearance.

The eggs of the Blow Fly may be deposited in wounds or on areas that are chafed or inflammed. During warm weather the eggs hatch quickly, releasing in a few hours a young larvae or maggot. This maggot feeds in the wound for three to nine days, and then pupates in any handy sheltered position on the sheep or may drop off and enter the soil. A period of from three to five weeks is required for development from egg to egg depositing. The Flesh Fly may deposit living larvae in a wound. These feed and grow for about six days, then leave the wound area to pupate. The time required for the pupation and emergence of the new fly is about two weeks.

Prevention—All dead animals of whatever sort should be buried deeply or burned at once. This removes a breeding place for these flies and thereby reduces their number in the district. Keep the sheep in as clean and dry condition as possible. Clip away any tags of soiled wool, saturate any inflammed areas with a creolin dip (one and a half per cent). Use a shepherd's crook to catch the sheep, and do not permit wool pulling.

Treatment—If any sheep or lambs show evidence of being fly blown, they should be removed from the flock and given such surgical treatment as is indicated. A disinfecting wash that is very useful can be made by adding three parts of carbolic acid to 100 parts of water. Dressings of pine tar may be applied after the maggots have been removed. A careful watch should be kept over the flock during warm weather, as these flies have a way of finding every wound, large or small, that appears on the body of a sheep or lamb. A small wire cut may become a very ugly wound if a female blow fly finds it.

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BULLETIN 338 SEPTEMBER, 1928

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

HINTS ON JUDGING

LIVE STOCK, POULTRY, GRAINS, GRASS AND CLOVER SEEDS, POTATOES AND ROOTS

By the Staffs of the Animal Husbandry Department, Field Husbandry Department and Poultry Department.

JUDGING LIVE STOCK.

The first essential for success in live stock work is that the man be a good judge. In order to accomplish this it is necessary to have a liking for live stock and to have a picture of the ideal animal in one's mind. This can be best acquired by working with live stock. Feeding and caring for them gives one an opportunity of learning the economy of the various types under one's charge. The perfect animal has not yet been produced and probably never will be, yet the successful judge must have the picture of that ideal in his mind's eye. Judging, then, is sizing up the animals before you and comparing them with the ideal and making the selection of the ones most nearly meeting the picture of the perfect one.

The experienced judge relies more upon his eyes than upon anything else. The type he is after is fixed in his mind. His eye immediately sizes up the animal before him and tells him where the defects are. Beginners are always too keen to crowd around and handle stock brought before them. All rings of stock or individual animals should be carefully sized up from a distance before any handling is done. Rely on the eye. First impressions are always better than the confusion which generally comes with too much mauling at close range. Size up the stock before you quickly, whether buying or judging. For the most part handle only to verify, or otherwise, first impressions.

With horses very little handling is necessary. The judge can see most defects without handling. It may be necessary to feel for side bones or to closely examine some hock malformation or to lift a foot. Sometimes you want to know how fat a horse is, but it is never necessary to feel, punch and rub a horse all over. In breeding cattle most of the judging is done by the eye. It is necessary to grasp a handful of the hide on the rib to get an idea of the quality of hair and the pliability of the skin, and it is well to note the depth of natural fleshing. No more handling is required. With dairy cattle the skin and hair must be felt and it is necessary to examine the udder, teats, milk veins and milk wells. In finished fat cattle the depth and evenness of fleshing are most important. The shoulder point, the rib, the back and loin must be evenly covered with a mellow, firm flesh. Handling is required to be sure of this and a pliable skin and soft, silky hair denote quality. With sheep, of course, more handling is necessary, but too much of it is generally done. As with other classes of stock, sheep should be sized up with the eye. While clever shepherds are able to trim to deceive, the trained eye takes in the general appearance and the judge is able to form some idea before he starts to handle. The sheep judge, when he commences to handle, should keep the fingers of his hands close together. He should get the filling of neck, the width of shoulder, the spring of rib, strength of top, width of loin, width over the rump and size of leg of mutton all with his hands flat and fingers close together. As he comes down the back he should get the depth of fleshing. He should finish his handling by opening the fleece low down just behind the shoulder, where the wool is finest, and well down on the thigh where it is coarsest. Swine require no handling only to feel the firmness of the fleshing in a fat class.

Method in judging is essential to consistent work. The good judge selects the animal that most nearly meets his ideal and then proceeds to line up the others which follow in type most consistently. Breaking type is not good practice, but must be done sometimes in classes of inferior animals where it becomes necessary to choose the lesser of two defects. As a general thing, it is good practice to follow type as set by the winner. Where large rings of stock must be placed it is often easier to cull out the losers and not worry any more about them. In small rings there is often an easy winner and an easy loser. These form a basis for the completion of the work.

Judging of live stock cannot be done by score card. Score cards are published simply to help the student to a better understanding of the various points of the different classes of animals. They have some little value also in teaching the relative importance of these points, but it is utterly useless to attempt to depend on a score card in actual judging practice. Know what to look for, then discard the score card.

SUGGESTIONS TO COMPETITORS "ON THE GIVING OF REASONS."

1. Be brief—speak distinctly and in a straight forward manner—if at all possible do not refer to notes when giving reasons to a judge.
2. Always compare animals or exhibits one with another or in other words, do not discuss animals or exhibits individually but compare your first prize exhibit with your second prize exhibit, your second prize exhibit with your third—your third with your fourth, telling the points in which it excels and also any outstanding point in which it may be deficient to the exhibit placed below in the class.
3. Mention the important points or reasons first, be sure of your statements—don't guess.
4. Do not memorize a book set of reasons and attempt to apply it to all classes.
5. Where a number of classes are to be judged before reasons are taken on any, it is generally wise to take brief notes on each class; these to be used only to assist in recalling the class to your mind's eye before appearing before the judge.
6. Classes are generally numbered from the left when standing behind them. Be sure of this point before marking your card.
7. Never use the words "I think" when giving reasons and if you use the word "better," be sure and tell in what way it is better.

The following illustrates a desirable method of giving reasons:

Example—Ring of 4 Shorthorn heifers.

1 placed the ring of Shorthorn heifers 4—2—3—1.

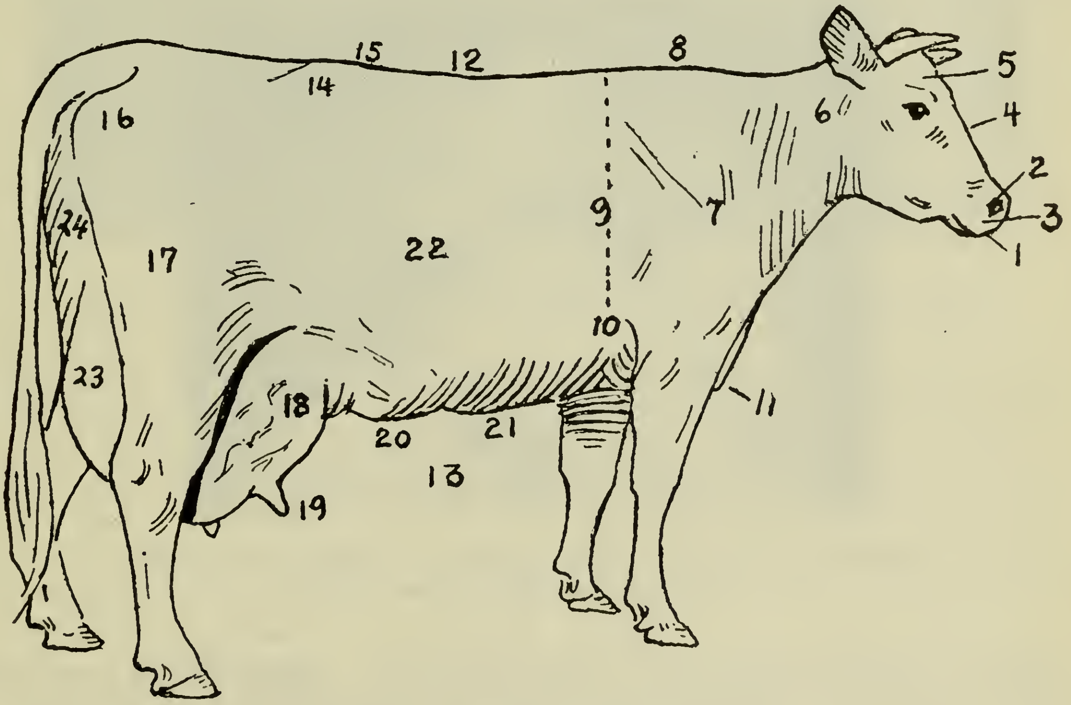
1 placed 4 over 2 because she is typier, being a blockier, thicker, heifer than 2. No. 4 also shows a little more Shorthorn character in her head it being cleaner cut and a little shorter between the eyes and muzzle. Admitting than No. 2 is a little smoother heifer, particularly at the pins, yet No. 4 is let down lower in the twist, carries her meat a little closer to the hocks and is thicker through the thighs. With that she is equally as well fleshed on the ribs and back and has greater width of loin and is fuller between the hooks and pins than No. 2.

1 placed 2 over 3 because she types in better with my first prize heifer, being lower set. No. 2 is also straighter in her lines, being stronger at the loin and let down lower at the rear flanks than No. 3. She is a smoother, more evenly fleshed heifer, the No. 3 being a little bare on her loin.

1 placed 3 over 1 because she is a much growthier heifer for her age, having greater depth at the heart, greater spring of rib, wider over the loin and better filled in the neck vein. I must admit that No. 1 is a little lower set, and a nicer handler, however, she is too fine and small for her age to be placed higher in this class.

DAIRY CATTLE TYPE.

Dairy type differs considerably from beef type. In the case of beef animals the ability to lay on flesh is the first essential, while in a dairy cow the ability to produce milk is of most importance. When judging or selecting a dairy cow, one must always bear in mind this function of economic production. As a manufacturing plant, the dairy cow must be



Points of a Dairy Cow.

1. Mouth
2. Nostril
3. Muzzle
4. Face
5. Forehead
6. Neck
7. Shoulder
8. Shoulder top or withers
9. Heart Girth
10. Chest
11. Breast
12. Topline
13. Underline
14. Hook bones
15. Loin
16. Pin bones
17. Thighs
18. Udder
19. Teats
20. Milk veins
21. Milk wells
22. Middle
23. Rear udder
24. Escutcheon

able to eat and digest an abundance of raw material; she must have the ability to thoroughly assimilate this raw material and convert it into blood constituents; she must have the necessary apparatus for secreting this material in the form of milk; and she must have the disposition to do so. Thus the cow must have:

1. A well-developed digestive system.
2. A strong constitution.
3. An active mammary system.
4. Marked dairy temperament.

A well-developed digestive system is indicated by a large barrel. This is obtained by length of body, width in the rear part of the barrel and general depth throughout. Consequently, a dairy cow must be long from the shoulders to the hips, wide across top from hip point to hip point, and must be deep from the rear of the loin to the base of the abdomen. This width at the hooks should be carried well forward, giving a wide loin throughout. The loin should be level, with the rear ribs well sprung. The rear ribs should be long, broad, flat and wide apart.

A strong constitution is indicated by great chest capacity, which demands depth from top to bottom of the body just back of the forelegs, thickness through the body at this region, width on the floor of the chest and fullness in the fore-flank. The fore-ribs should spring out quite strongly, and descending, obtain their greatest width one-third to one-half way down the body, thus giving ample room for heart and lung development.

Showing the broad loin, prominent chine, and spring of rib, all essential in dairy type.

With a width of fore-rib, a prominence or roughness of the shoulder should be avoided. The shoulder must lie smoothly and the dorsal vertebrae should extend above the points of the shoulder blade. Any prominence of shoulder indicates too much flesh between the shoulder blade and the front rib, and this development of flesh is not desired. In dry cows that are well fed in preparation for their next lactation period, a breadth across the top of the shoulder naturally develops due to the fat deposited beneath the shoulder blade, so allowance must be made between dry cows and those milking. A large well-developed nostril is another indication of lung development.

To secrete milk a cow must have a well-developed mammary system. The udder should be large and of good quality. It should be long between the rear and forward attachments, extending high between the thighs. It should be broad and well filled in the rear and forequarters with no noticeable division between the quarters. It should also be well balanced, that is, each quarter of the the same size. The sole or bottom of the udder should be level and run well forward on the abdomen. In quality the udder should be soft, pliable and elastic. A coarse, firm, non-elastic udder is an indication of too much fibrous non-secreting tissue. The teats should be placed squarely in the centre of each quarter. They should be large enough for comfortable hand-milking. Very short teats are objectionable, and there is no advantage in undue length and size. The teats should be regular in shape and of fair thickness.

Showing a well-balanced udder, slightly cut between fore and rear quarters. Note the placing and uniformity in size of teats.

The milk veins, or the large abdominal veins running forward from the udder upon the lower surface of the abdomen, carry the blood from the udder back to the heart. These should be long, large, tortuous and branched and should enter the abdominal wall through large orifices called the milk wells. The size and development of these milk veins and milk wells are indications that a large flow of blood is passing through the udder and consequently there is opportunity for a large milk secretion.

Dairy temperament is absolutely essential in a dairy cow. This is indicated in many ways. It is shown by a natural leanness throughout. The head should be clean-cut and long from the eyes down to the muzzle. The forehead should be broad, the eyes prominent, full and placid, the neck long and lean. The spine should project above the shoulders at the withers and should show prominence and openness right down the back. The dairy cow should show a freedom from meat and meat-carrying tendencies, so a light loin, a thin thigh and an open twist are always looked for. The rear ribs should be broad, flat and widely spread.

Quality is of utmost importance in a dairy cow. This is evidenced in a loose, mellow, fairly thin skin, fine, soft, bright, oily hair, and smooth, fine, clean bone. The cow should have a fineness about the head, a fine horn, a freedom from coarseness about the shoulder or hooks, and a fine, slim tail. A coarse cow, lacking in quality, is almost certain to give smaller returns for the feed consumed.

The general appearance of the dairy cow also plays an important part in her make-up. Most dairymen prefer a large cow. All animals should have a straight, strong top line from head to tail. This adds to their appearance and helps in selling the individual. Weak backs and drooping rumps are particularly objected to. A cow with a weak back is less active and tires more readily and consequently is a less useful cow. A drooping rump is naturally accompanied by an udder that lacks development in forequarters. The rump should also be wide at the pins in order to give more width for attachment of udder behind. There is a direct correlation between shape and attachment of udder and the conformation of the rump of a cow. The length of attachment of udder is determined by the length of rump. A short rump necessitates a short udder.

A dairy cow should also be deep and fairly low set. The long-legged cow is usually shallow in body and much harder to feed economically.

A dairy cow should show considerable style of carriage. She should carry her head erect and have an alert and graceful appearance. She should be well-proportioned so that all parts are in harmony, and should stand well on her legs. Along with this active and alert bearing she should show no signs of any viciousness and should not be easily alarmed. She should have full confidence in her master.

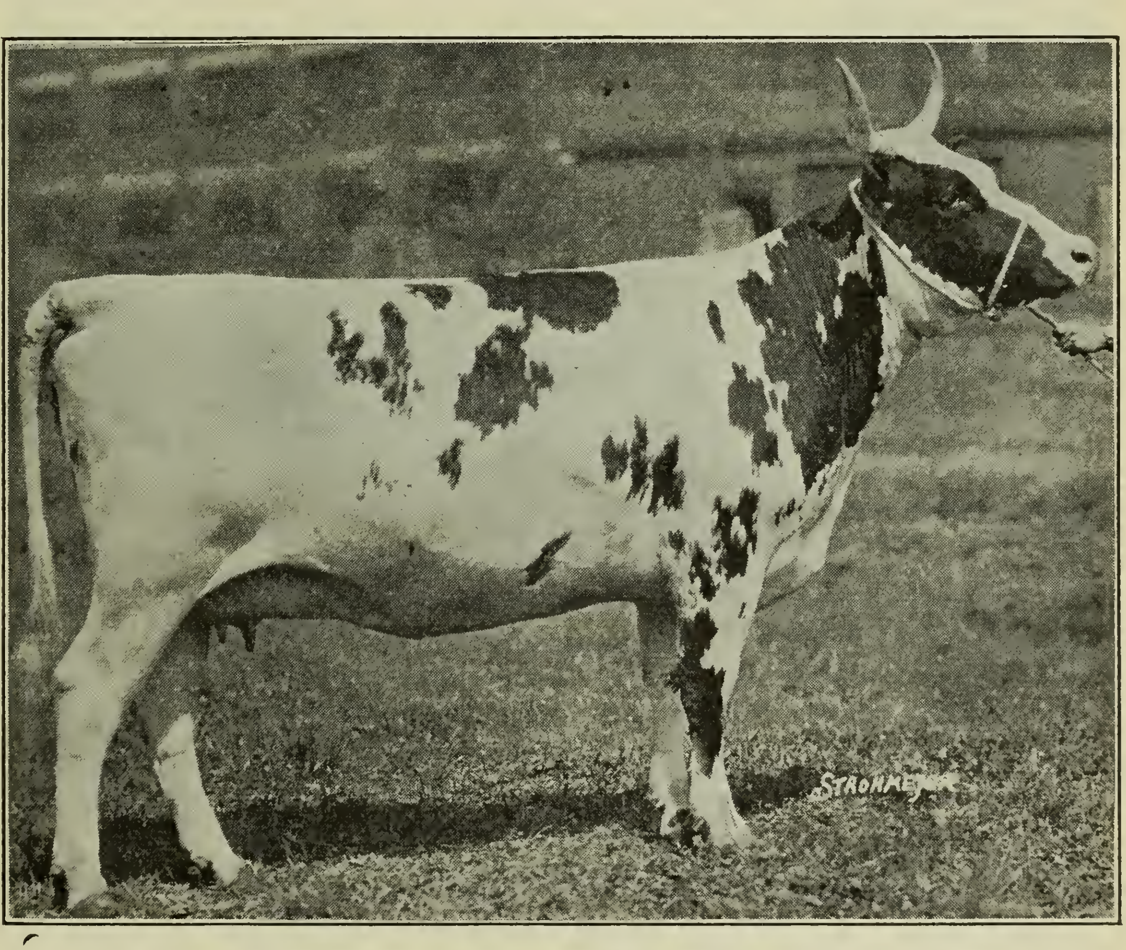
Besides all this, she should show considerable femininity. This term stands in opposition to that of masculinity as applied to males. Fineness in the face and contour of the head, lightness in the horn, fineness in the neck and lightness in the brisket and shoulder are all feminine characteristics. Femininity, besides being a guide to milk production in a cow, is a sign of a regular and reliable breeder as well.

SCALE OF POINTS.

	Possible Score
Estimated weight .... pounds	
Form—Wedge-shaped as viewed from front and top; straight top line, and great depth of barrel	5
Quality—Hair, soft and fine; skin, of medium thickness, mellow and elastic; secretion, yellow; bone, fine and clean	6
Style—Active, vigorous, showing strong character; temperament, inclined to nervousness, but not irritable or vicious	5
Muzzle—Broad and clearly defined; mouth and nostrils large	1
Eyes—Large, prominent, clear and placid	1
Face—Lean and somewhat long, fine between muzzle and eyes	1
Forehead—Broad	1
Ears—Of fine texture, and medium size; secretion, abundant	1
Neck—Thin, rather long, fine and clean at junction with head—no noticeable amount of dewlap	3
Withers—Lean and sharp; vertebrae, somewhat higher than blades	2
Shoulders—Light, good distance through from point to point, but sharp on top; smoothly blended into body	2
Legs—Well apart, straight and short; shank, fine and smooth	2
Chest—Deep, full between and back of fore-legs, no depression behind shoulder blade	6
Ribs—Long, broad, and wide apart; well sprung; giving a large, deep barrel	10
Back—Lean, straight, and open-jointed; sharp chine and broad loin	6
Hooks—Wide apart	2
Rump—Long and wide	3
Pin Bones—High and wide apart	1
Thighs—Thin	2
Legs—Straight and set well apart; shank, fine and smooth	2

Escutcheon—Spreading over thighs and extending far upwards	2
Tail—Long and fine, terminating in a switch of fine hair	1
Udder—Long, wide, deep, but not pendulous, firmly attached, extending well up behind and far forward; quarters even and free from fleshiness	25
Teats—Large, uniform, and evenly placed	5
Milk Veins—Large, long, crooked and branching	3
Milk Wells—Large and numerous	2
Total	100

CHARACTERISTICS OF THE FOUR LEADING DAIRY BREEDS IN ONTARIO.



BURNSIDE BLOSSOM ANDRIETTA—74206.
Noted show-winning Ayrshire. Shown in heifer form

AYRSHIRE—

The Ayrshire may be considered medium in size; mature cows weighing on an average of about 1,100 pounds, and bulls from 1,500 to 1,800 pounds. In colour they are brown and white, the brown ranging from very light brown to almost black. The colours are distinct and should not blend to form a roan. The head is comparatively short for dairy type, clean-cut with good width between the eyes and crowned with somewhat large horns of distinctly erect carriage. The breed is outstanding for its capacious, well-balanced, closely-attached udder and the teats which are well placed. The Ayrshire is very clean-cut in appearance, with only a fair length of neck but generally very smooth throughout and has a good spring of rib. They are inclined to a little more thickness through the thighs than is found in either the Jersey or Guernsey.

SCALE OF POINTS FOR AYRSHIRE COW.

		Score
Head		10
Forehead—Broad and clearly defined	1	
Horns—Wide set on and inclining upward	1	
Face—Of medium length, slightly dished; clean cut, showing veins	2	
Muzzle—Broad and strong without coarseness, nostrils large	1	
Jaws—Wide at the base and strong	1	
Eyes—Full and bright with placid expression	3	
Ears—Of medium size and fine, carried alert	1	
Neck—Fine throughout, throat clean, neatly joined to head and shoulders, of good length, moderately thin, nearly free from loose skin, elegant in bearing		3
Fore Quarters		10
Shoulders—Light, good distance through from point to point, but sharp at withers, smoothly blending into body	2	
Chest—Low, deep and full between and back of forelegs	6	
Brisket—Light	1	
Legs and Feet—Legs straight and short, well apart, shanks fine and smooth, joints firm, feet of medium size, round, solid and deep	1	
Body		13
Back—Short and straight, chine lean, sharp and open jointed	4	
Loin—Broad, strong and level	2	
Ribs—Long, broad, wide apart, and well sprung	3	
Abdomen—Capacious, deep, firmly held up with strong muscular development	3	
Flank—Thin and arching	1	
Hind Quarters		11
Rump—Wide, level, long from hooks to pin bones, a reasonable pelvic arch allowed	3	
Hooks—Wide apart and not projecting above back nor unduly overlain with fat	2	
Pin Bones—High, wide apart	1	
Thighs—Thin, long and wide apart	2	
Tail—Fine, long and set on level with back	1	
Legs and Feet—Legs strong, short, straight, when viewed from behind and set well apart; shanks fine and smooth, joints firm, feet medium size, round, solid and deep	2	
Udder—Long, wide, deep but not pendulous nor fleshy; firmly attached to the body, extending well up behind and far forward; quarters even, sole nearly level and not indented between teats, udder veins well developed and plainly visible		22
Teats—Evenly placed, distance apart from side to side equal to half the breadth of udder, from back to front equal to one-third the length; length 2½ to 3½ inches, thickness in keeping with length, hanging perpendicular and not tapering		8
Mammary Veins—Large, long, tortuous, branching and entering large orifices		5
Escutcheon—Distinctly defined, spreading over thighs and extending well upward		2
Colour—Red of any shade, brown or these with white; mahogany and white or white, each colour distinctly defined (Brindle markings allowed, but not desired)		2
Covering		6
Skin—Medium thickness, mellow and elastic	3	
Hair—Soft and fine	2	
Secretions—Oily, of rich brown or yellow color	1	
Style—Active, vigorous, showing strong character, temperament, inclined to nervousness, but still docile		4
Weight—At maturity not less than 1,000 pounds		4
Total		100

HOLSTIEN-FRIESIAN—

This is the largest of the four breeds, mature cows weighing from 1,100 to 1,600 pounds, with an average weight of about 1,350 pounds. A mature bull should weigh from 1,800 up to 2,500 pounds. In colour they are black and white. These colours should be distinct, with no tendency to blend. The head of the Holstein-Friesian is rather long, lean and clean-cut with a strong muzzle. The face is fairly straight with good width between the eyes and the horn generally fine, white in colour with black tips. The horn is inclined to be short, coming straight out from the poll, turning inwards and slightly downward.

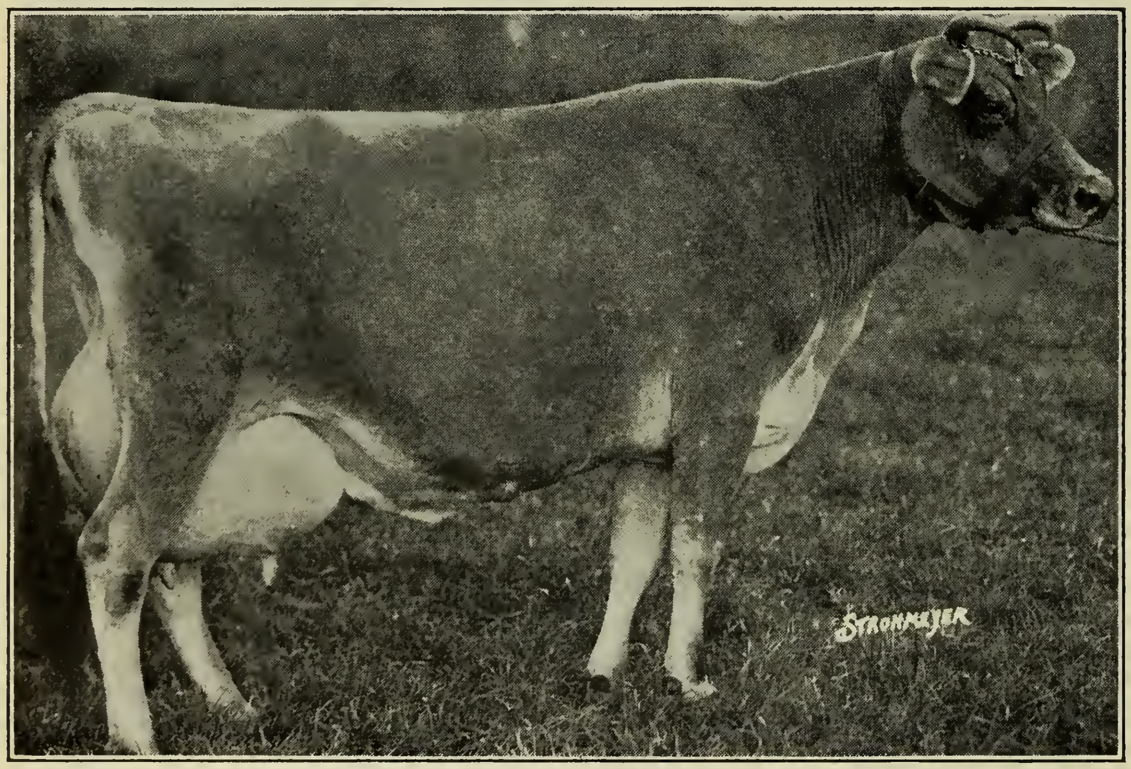
Elmcrest Ormsby Fayne—49090.
Combining type with production.
728.8 pounds of milk, 38.11 pounds butter in seven days.

Scale of Points for Mature Holstein-Friesian Cow.

Parts	Score
Forehead—Broad between the eyes; dishing	2
Face—Of medium length; clean cut; feminine, the bridge of the nose straight	1
Muzzle—Broad, with strong lips, nostrils large and open; jaws strong	3
Ears—Of medium size; of fine texture; well carried	1
Eyes—Large, full; mild; bright	2
Horns—Small; tapering finely towards the tops; set moderately narrow at base; inclining forward; well curved inward	1
Neck—Long; fine and clean at junction with the head; evenly and smoothly joined to shoulders	3
Shoulders—Slightly lower than the hips; smooth and rounding over tops; moderately broad and full at sides	3
Crops—Full; level with the shoulders	5
Chine—Straight, strong; broadly developed, with open vertebrae	4
Loin and Hips—Broad; level or nearly level between the hip bones; level and strong laterally; spreading from chine broadly and nearly level; hip bones fairly prominent.	6
Rump—Long, broad with roomy pelvis; nearly level laterally; full above the thurls; carried on straight to tail head	6
Pinbones—Wide between; nearly level with hips	2
Thurls—High; broad through	2
Head and Tail—Strong at base without coarseness; the setting well back; tail long, tapering finely to a full switch	2
Chest—Deep; wide; well filled and smooth in the brisket; broad between the fore-arms; full in the foreflanks	6
Barrel—Long, deep; well rounded; strongly and trimly held up	9
Flanks—Deep; full	2
Thighs—Wide; deep; straight behind; wide and moderately full at the outsides; twist well cut out and filled with development of udder; with escutcheon well defined	2

Mammary Veins—Large; tortuous; entering large orifices or double extension; with additional developments, such as branches and connections entering numerous orifices	8
Udder—Capacious; flexible; quarters even and of uniform texture; filling the space in the rear below the twist; extending well forward; broad and well attached	14
Teats—Well formed; plumb; of convenient size; properly placed	4
Legs—Medium length; clean; nearly straight; wide apart; firmly and squarely set under the body; arms wide, strong and tapering	4
Hair and Hide—Hair healthful in appearance; fine and soft; hide of medium thickness; mellow and loose	8
Total	100

Jersey—



Brampton Seaside Lass—4671.

Champion Jersey Cow, National Dairy Show, St. Paul, 1921, and Royal Winter Fair, 1923.

They are smallest of the four breeds. Mature cows will weigh from 800 to 1,000 pounds, while bulls vary from 1,300 to 1,700 pounds. They are very refined and possess outstanding quality, smoothness and general dairy type. The head is very clean-cut and comparatively short with a slightly dished face and great width between the eyes. Too much width at poll is objectionable. The eyes are large and very prominent. Great stress is placed by breeders upon the udder which should be well-balanced, attached well up behind and well ahead on the belly. Teats should be of good size and well placed on the udder. The colour of the Jersey varies from a light silver grey to seal brown, almost black. White markings are not objectionable.

SCALE OF POINTS FOR JERSEY COW.

		Score
Head		7
A—Medium size, lean; face dished; broad between eyes; horns medium size, incurving	3	
B—Eyes full and placid; ears medium size, fine, carried alert; muzzle broad, with wide open nostrils and muscular lips; jaw strong	4	
Neck		4
Thin, rather long, with clean throat, neatly joined to head and shoulders	4	
Body		37
A—Shoulders light, good distance through from point to point, but thin at withers; chest deep and full between and just back of fore legs	5	
B—Ribs amply sprung and wide apart, giving wedge shape, with deep, Large abdomen, firmly held up, with strong muscular development	10	
C—Back straight and strong, with prominent spinal processes; loins broad and strong	5	
D—Rump long to tail setting, and level from hip bones to rump-bones.	6	
E—Hip bones high and wide apart	3	
F—Thighs flat and wide apart, giving ample room for udder	3	
G—Legs proportionated to size and of fine quality, well apart, with good feet, and not to weave or cross in walking	2	
H—Hide loose and mellow	2	
I—Tail thin, long, with good switch, not coarse at setting-on	1	
Udder		26
A—Large size, flexible and not fleshy	6	
B—Broad, level or spherical, not deeply cut between teats	4	
C—Fore udder full and well rounded, running well forward of front teats.	10	
D—Rear udder well rounded, and well out and up behind	6	
Teats		8
Of good and uniform length and size, regularly and squarely placed	8	
Milk Veins		4
Large, long, tortuous and elastic, entering large and numerous orifices	4	
Size		4
Mature cows, 800 to 1,000 cows	4	
General Appearance		10
A symmetrical balancing of all the parts, and a proportion of parts to each other, depending on size of animal, with the general appearance of a high-class animal, with capacity for food and productiveness at pail	10	
Total		100

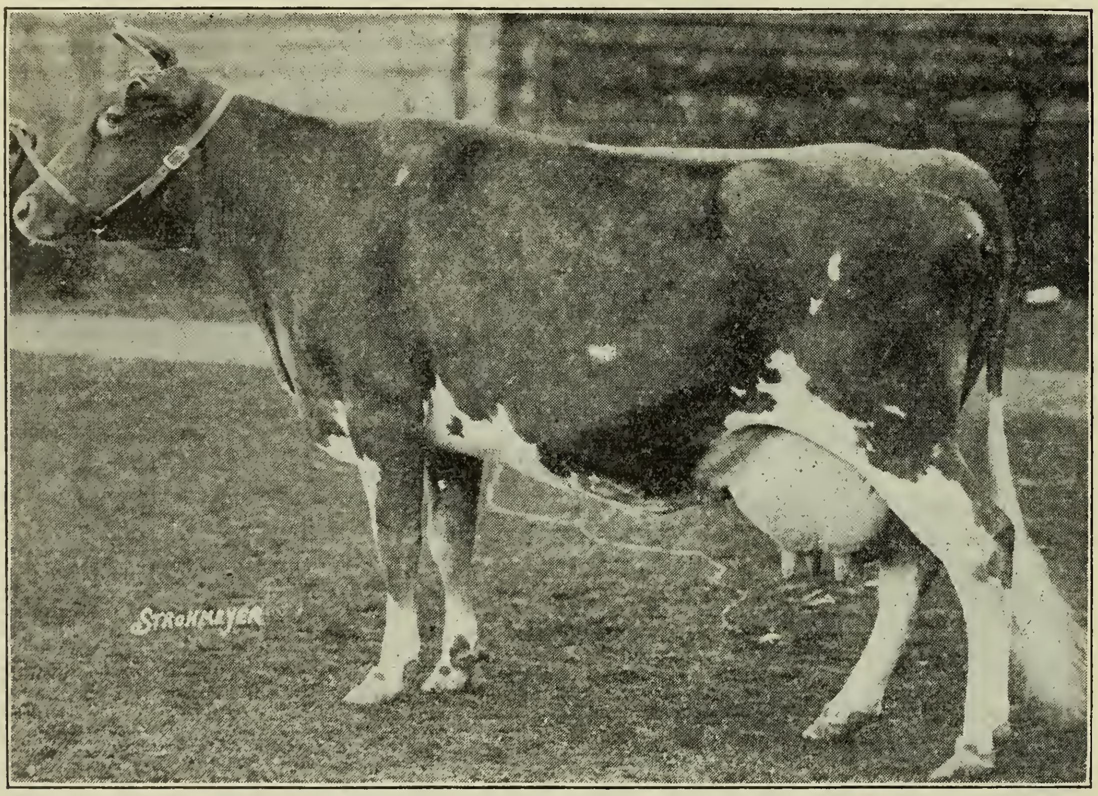
GUERNSEY—

They are considerably larger than the Jersey. The cows will average around 1,100 pounds and the bulls 1,600 pounds. In colour the Guernsey is orange, yellow or fawn with white markings. The muzzle is buff or flesh coloured and is surrounded by light-coloured hair as are the eyes. The horns and hoofs are usually amber-coloured. The colour of the skin is a rich yellow and is a point much emphasized by breeders as indicating yellow colour of product. The head of the Guernsey compared with the Jersey is slightly longer and the face lacks the dish common to the Jersey. Horns should be small and gracefully curved inwards. While not showing as much smoothness as the Jersey, the Guernsey shows good dairy type and swings a good sized udder of fairly good balance.

SCALE OF POINTS FOR THE GUERNSEY COW.

Head—Clean cut, lean face, wide mouth and muzzle with open nostrils, full, bright eye with gentle expression. Forehead long, broad between the eyes and dishing	6
Horns—Small at base, medium length, not too spreading	1
Neck—Long, and thin; clean throat	2
Withers—Chine rising above shoulder blades that are moderately thick and not coarse	3

Back—Straight from withers to hips	8
Hips—Wide apart, not too prominent	2
Rump—Long, continuing with level of the back, also level between hip bones and pin bones	5
Thurls—Wide apart and high	2
Chest—Wide, and deep at heart, with least depression possible back of the shoulders	4
Body—Deep and long, with well-sprung ribs which are wide apart. Broad loin. Thin arching flank	10
Thighs—Thin, incurving seen from side, and wide apart from rear	2
Legs—Comparatively short, clean, wide apart and nearly straight when viewed from behind, squarely set under body	2

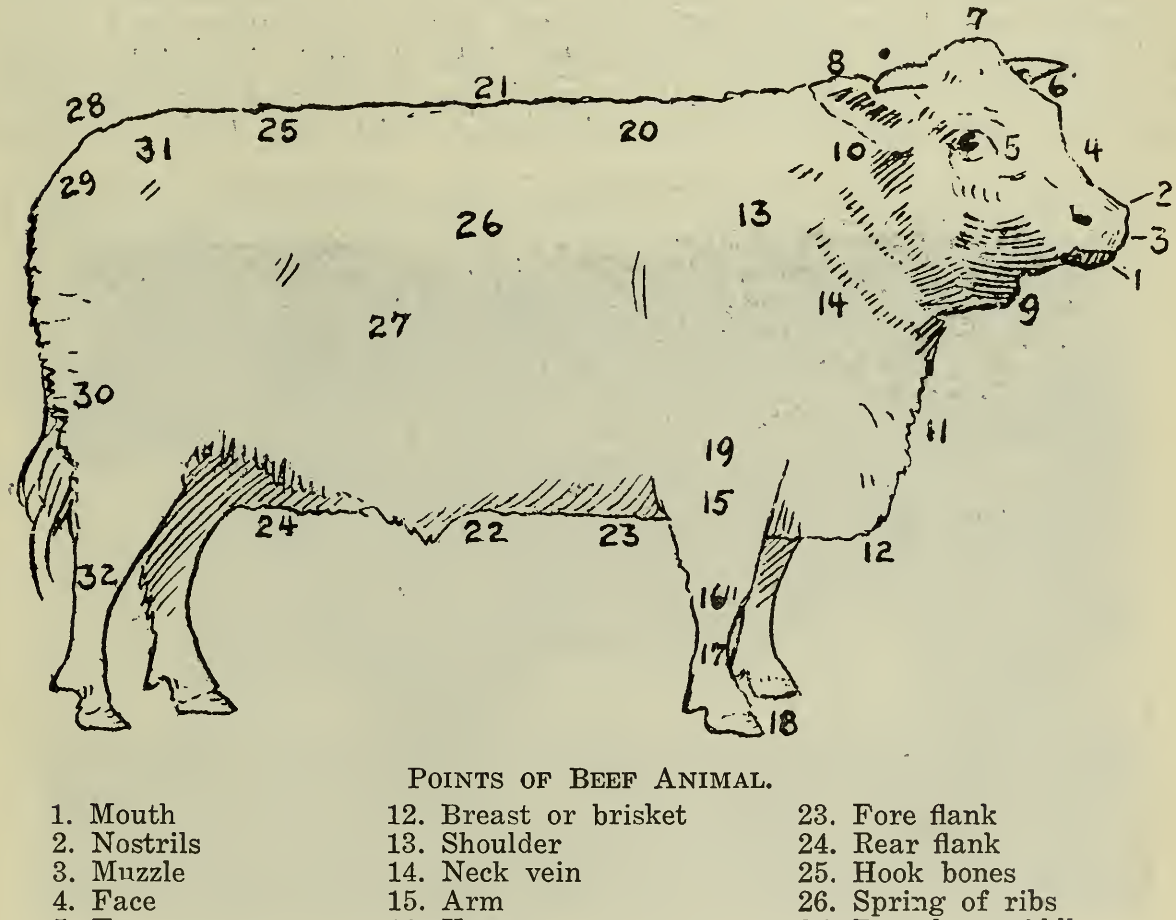


Glen Gable Emblem.
Grand Champion Guernsey Cow at the Royal, 1926.

Hide—Loose and pliable, and not thick, with oily feeling	3
Tail—Neat and firm setting on, long, good switch	1
Udder—Veins prominent	2
Attachment to body long and wide	2
Extending well forward	5
Level and well up behind	4
Teats of good even size, well apart and squarely placed	5
Milk Veins—Long, crooked, branching and prominent with large deep wells	4
Secretions—Indicating Colour of Product—Indicated by the depth of yellow, inclining toward orange of the pigment secretion in the skin, on the body generally and especially discernible in the ear, at the end of bone of tail, around the eye, on the udder and teats and at the base of horns. Hoofs and horns amber-coloured	20
Colour Markings—A shade of fawn with white markings	2
Size—Mature cows about 1,100 lbs. in milking condition	5
Total	100

BEEF CATTLE TYPE.

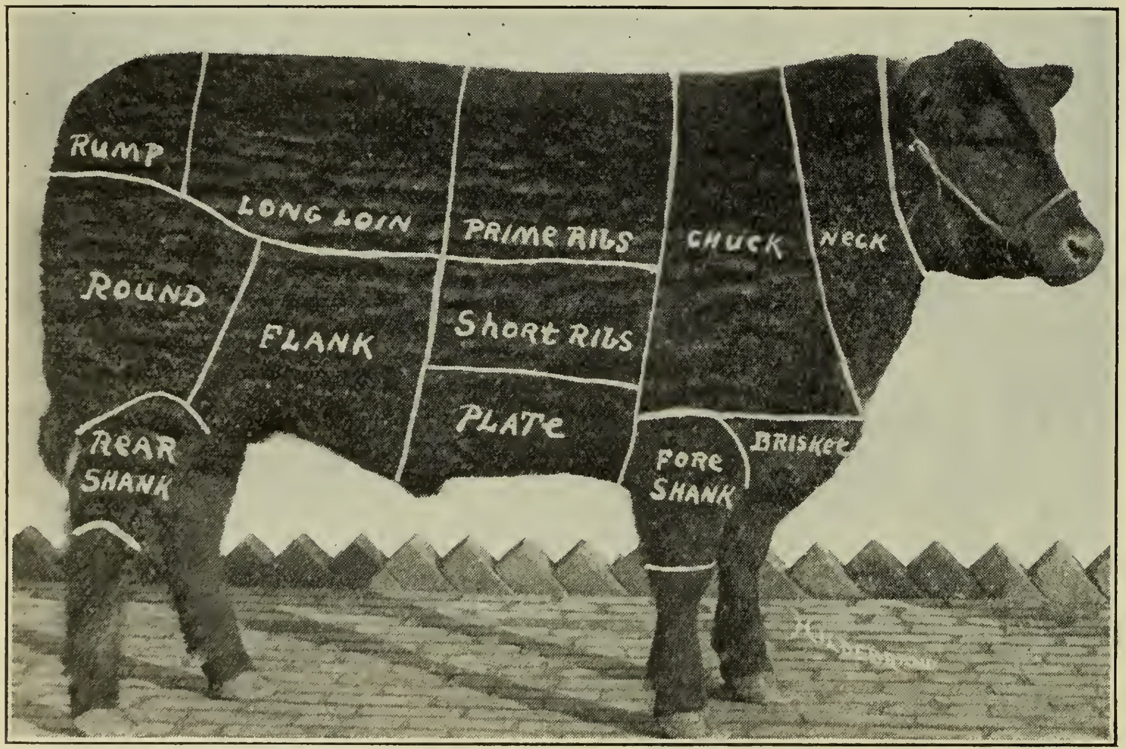
The beef animal must be low set, deep of body, very thick, and must show a strong, straight top and a straight underline carried well down at the fore and rear flanks. In fact, the best type is filled out in conformation to give the appearance of almost a perfect rectangle. It is important that the portions of the body which furnish the best cuts in the carcass should be well developed. This means a great spring of rib and wide, deep loins and well filled rounds. In general appearance the beef animal should show close to the ground with all the depth and thickness to make a well-balanced animal.



Points of Beef Animal.

1. Mouth
2. Nostrils
3. Muzzle
4. Face
5. Eye
6. Forehead
7. Poll
8. Ear
9. Throat
10. Neck
11. Dewlap
12. Breast or brisket
13. Shoulder
14. Neck vein
15. Arm
16. Knee
17. Shank
18. Hoof
19. Elbow
20. Crops
21. Topline or back
22. Underline
23. Fore flank
24. Rear flank
25. Hook bones
26. Spring of ribs
27. Barrel or middle
28. Tail head
29. Pin bones
30. Thighs
31. Rump
32. Hock

The head generally indicates what goes behind it. A short, broad head and a large, strong muzzle, a short face, wide between the eyes and at the poll, is generally an indication of a good feeder and almost always goes with the thick, low down kind. The neck should be short and thick, but the junction of the head and neck should be clean cut with an absence of throatiness and with a light dewlap. The filling at the neck vein at the junction with the shoulder should be smooth and the shoulder should be well set into the body and covered with flesh showing wide on top, which indicates a large amount of lean meat under the shoulder blades. Prominent, rough shoulders are very objectionable, because they generally go with an animal that is heavy in front producing too large a percentage of cheap meat. The shoulder should blend well into the body, leaving no depression in heart girth. This means that the animal must show a great spring of rib which should be carried well down to the fore flanks, giving plenty of capacity on the floor of the chest which should end in a full, blunt, firmly carried brisket. The spring of rib, so necessary to constitution and wide and full to give floor space for the laying on of an abundance of flesh in the region known as the prime rib, should be carried right back over the body giving the animal a large middle and capacity to handle feed in sufficient quantity to make good beef cheaply. The top line and underline should be straight and parallel. Straight tops denote strength, and generally speaking the flesh is laid on more evenly on straight backs than on weak or hollow-backed animals. A straight underline means that the animal is equally well let down in fore and rear flanks. An animal cut up in fore flanks generally lacks constitution and one cut up in the rear flank is almost invariably light through the thighs or buttocks. The loin, one of the most valuable parts of the animal should be broad and deep and well covered with meat, with the hook bones set smoothly into the body so that the animals will hang a straight side of beef. The rump between hook and pins should be long and level and well and smoothly fleshed. The good beef animal is low in the twist, thick through the thighs and carries the meat well down to the hocks. The legs, while short, should show a fine quality of bone, heavy enough to carry the body weight, but not coarse and rough. Over the entire body there should be a wealth of natural fleshing, smoothly laid on with an absence of patchiness or rolling. The flesh should be mellow in character, firm but not hard and tallowy nor yet soft and flabby. The skin should be soft and pliable, not too thick nor yet too thin. Papery hides generally go with poor feeders, and thick, heavy, leathery skins generally indicate lack of quality. In sizing up a beef animal, it must always be remembered that the high-priced cuts of meat come from the upper part of the body, from a point behind the shoulder, right over the back and down the



Showing the wholesale cuts on Glencarnock Victor 2nd. A Chicago champion and an excellent type of show steer.

hindquarter. This portion constitutes about half the carcass and it is in this region that the butcher gets his best meat, but the breeder and feeder must remember that depth of body, constitution and middle are necessary to the development of this choice meat down the back.

To show the importance of the so-called best cuts of meat and their relation to conformation, it may be stated that the loin and prime ribs, which constitute the most valuable cuts in the carcass, make up, on the average, about twenty-six per cent of the carcass, seventeen per cent being loin and nine per cent being ribs. This amount, which is approximately one-quarter of the carcass, is actually worth nearly fifty per cent of the entire value of the carcass. The rounds, on the average, constitute about twenty-three per cent of the carcass when the rump is attached. Next to the loin and ribs this is the most valuable cut and with the loin and ribs comprises about three-quarters of the value of the carcass. The chuck constitutes about twenty-six per cent of the carcass and is largely made up of the shoulder. It is comparatively cheap meat, but is worth a little more than plates, flanks, shanks, etc., which constitute the remaining twenty-five per cent of the beef carcass. We give these figures here simply to show the importance of the best possible development of loins, ribs and rounds in the beef animal and also to show the reason why light briskets, smooth shoulders and trim underlines are asked for in the finished beef animal.

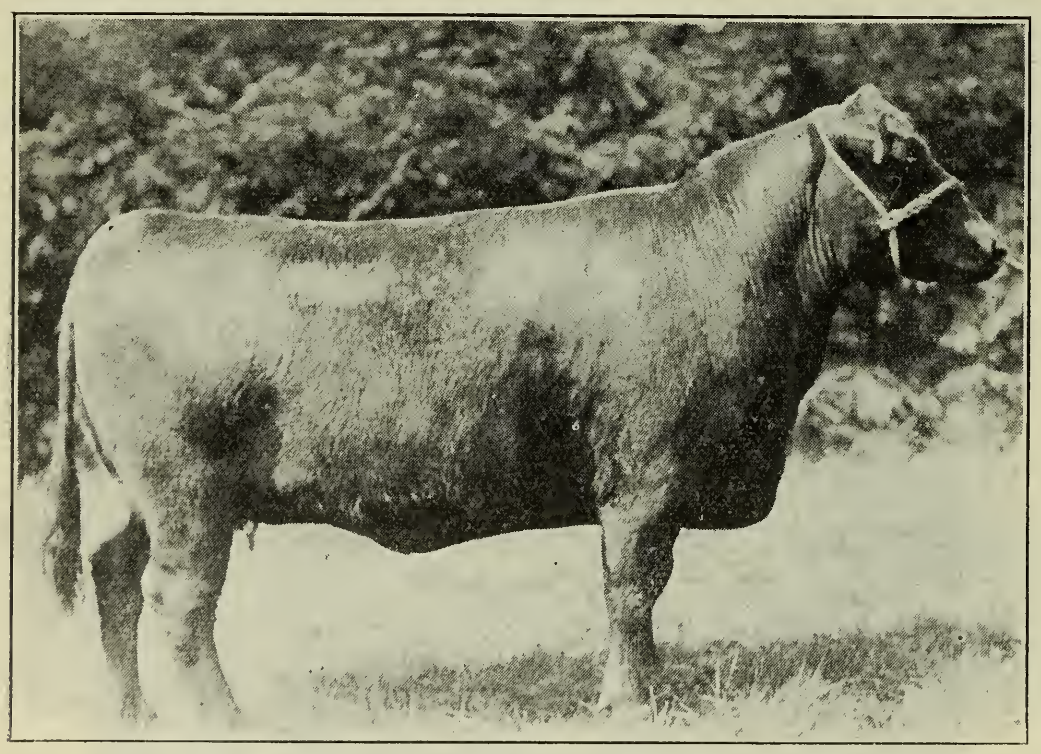
QUARTERCUP, 174941.

Shorthorn Herd Sire at the Ontario Agricultural College.
Photo as a three-year-old. Weight 2,230 lbs.

CATTLE BREEDING CLASSES.

The true beef form is the first essential in judging breeding classes of beef cattle. There is no fundamental difference in form between breeding beef animals and feeders or fat steers. The same deep, broad, thick-set animal is the one the breeder is trying to produce. When judging cattle to be used for breeding purposes, or pure-bred beef cattle, attention must not only be paid to the requirements of the feeder, but to any indication in the animal that such good qualities as he or she possesses will be transmitted to their offspring. This is usually estimated by masculinity in the bull and femininity in the female. The bull should show a masculine head, a full forehead, strong horn and withal a heavy and burly but not coarse appearance. The neck should be full with a well developed crest, the shoulders should be strongly developed but not coarse. The female should show greater refinement throughout. The head, neck and shoulders should be free from the heavy appearance as seen in the bull and should show fineness and quality. The skin should be thinner and mellower and the hair finer and silkier. The hips should be wider and more prominent than in the bull.

Pure-bred animals should also show breed character. That is, colour, shape of head, blockiness, spring of rib, and other indications that show purity of breeding, should be taken into consideration.



College Maid, 20675.
Angus cow, bred and owned by the O.A.C. A good type of breeding matron.

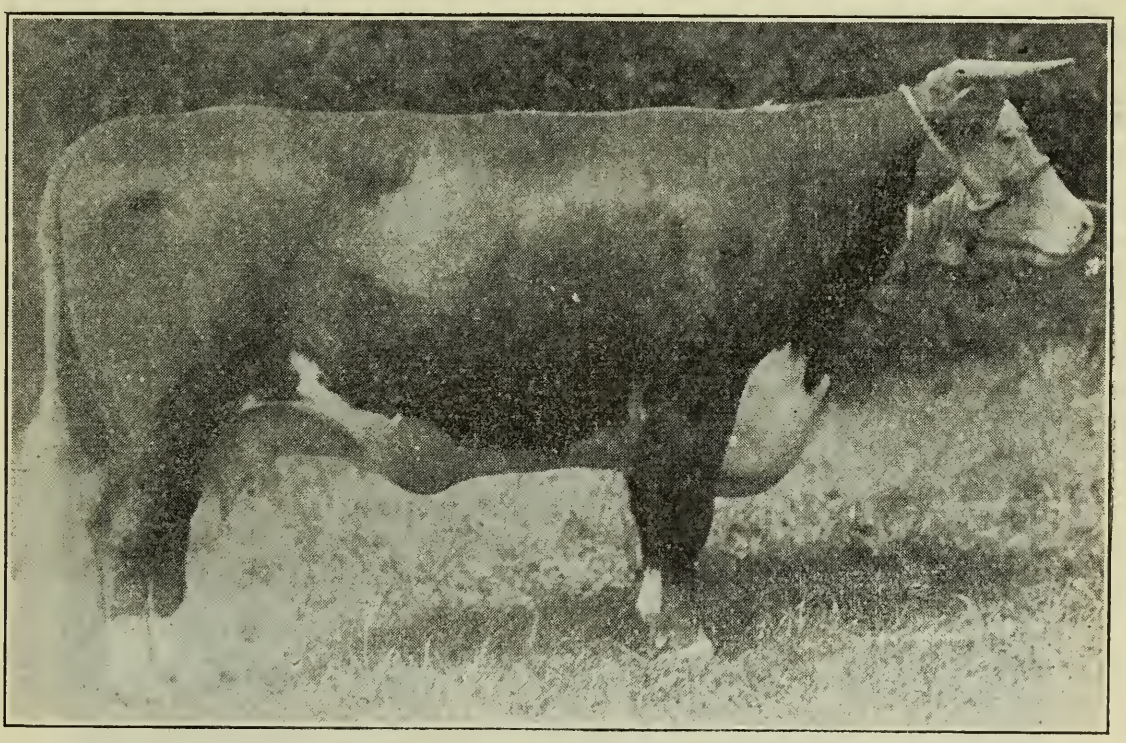
BRIEF CHARACTERISTICS OF THE THREE LEADING BEEF CATTLE BREEDS IN ONTARIO.

SHORTHORN—

Shorthorn cattle are among the heaviest of the beef cattle breeds. Mature cows should weigh 1,300 to 1,500 pounds or more and bulls 1,800 and up to 2,500 pounds. In colour they may be red, white, roan or any combination of these colours. Very light red is objected to as is also spotted intermingling of the three colours. Black should not occur and dark muzzles are decidedly objectionable. The head should conform so that described under beef type and the horn should be fine and flat, preferably coming out straight from the poll then turning inward and slightly downward.

HEREFORD—

In size this breed compares favourably with the Shorthorn and the average weights for both male and female would be similar to those of that breed. The colour of the Hereford is a distinguishing feature with the body cherry red and the face, head top of neck and brisket generally white. The markings of white generally extend well down the back and the underline is also generally white as is also the switch and usually some white is to be found on the legs below the knee and hock. A light yellowish red or an unduly dark red may be found frequently, but it is not as desirable a colour as a bright cherry red. The horns should be flat and fine and preferably should turn inward and downward.



MISS BRAE 94TH, 613829.
A former champion Hereford cow, one of the goods ones in the O.A.C. herd.

ABERDEEN ANGUS—

In colour they should be almost solid black, very little if any white being found on a high class, pure bred Angus. Occasionally a little white is seen on the underline or udder of cows. Bulls should weigh from 1,800 to 2,200 pounds or more and cows from 1,200 to 1,500 pounds. This breed represents the butchers' ideal of a beef animal, being very low set, deep and exceedingly smooth. The head is clean-cut, short, broad and has a sharp distinct poll and bears no horns. The Aberdeen Angus is also characterized by having an almost cylindrical spring of rib.

THE FOLLOWING IS A SATISFACTORY SCALE OF POINTS FOR BEEF CATTLE.

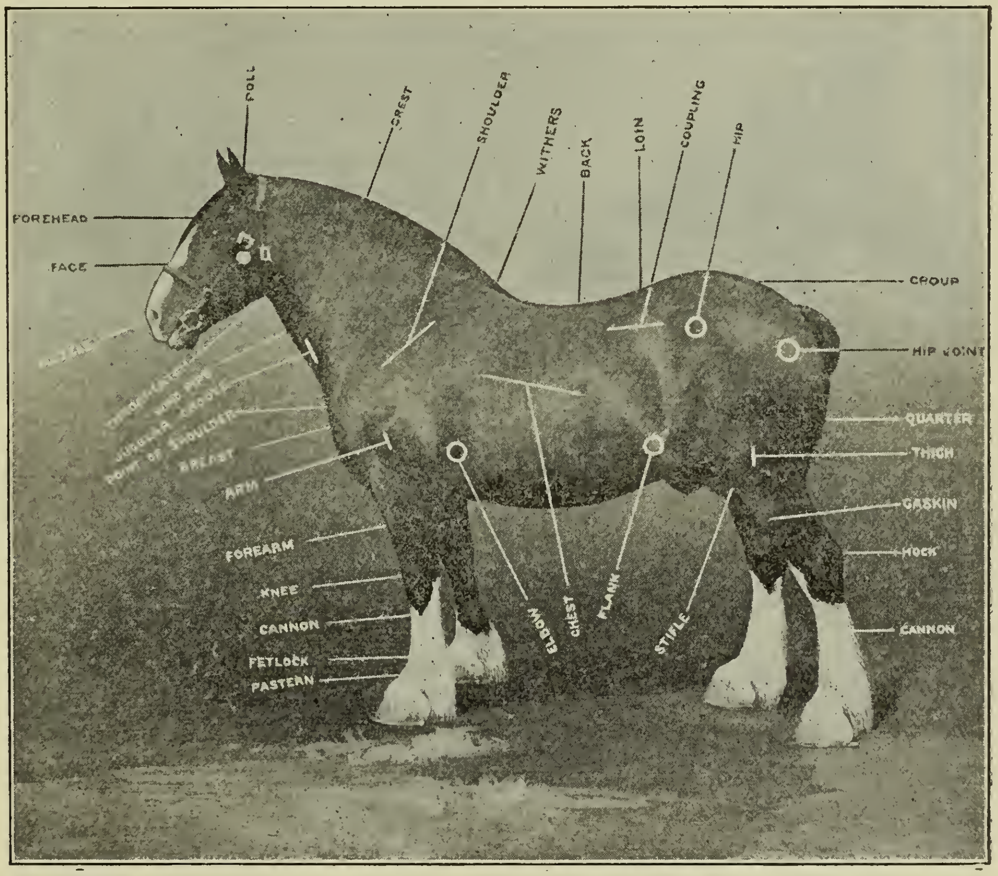
	Possible Score
Estimated weight .... pounds	
Weight, according to age	4
Form, deep, broad, low set, smooth; top line and underline, straight..........	8
Flesh, naturally thick fleshed. (See further under quality)..........................	4
Quality, bone strong, but of fine texture and clean; skin, pliable and elastic; hair, soft and thick. All parts evenly covered with firm flesh, which should be mellow to the touch, but not soft and flabby nor yet in hard rolls or ridges	8

Style, active and vigorous, but not restless; should show strong character	4
Muzzle, broad and clearly defined; mouth, large, nostrils, large	2
Eyes, large, prominent, clear and placid	2
Face, short, with clean cut appearance	1
Forehead, broad	1
Ears, medium size and fine texture	1
Neck, thick and short, with full neck vein; junction of neck with head clearly defined. In bull, crest well developed	5
Horns (when present), fine in texture, flattened at base, not more than medium size	.
Shoulders, smooth, covered with flesh, well laid back into ribs, compact and moderately broad on top	5
Brisket, prominent and blunt; breast, full and wide	3
Dewlap, light	1
Legs, straight and short; arm, broad and well muscled; bone, flat, clean and strong	2
Chest, deep and wide; fore flanks, full; space back of shoulders well filled, leaving no depression; heart girth, large	9
Ribs, long, well arched; thickly fleshed	5
Back, broad, straight, well fleshed and smooth	7
Loin, deeply fleshed, coming out full to hooks and carrying width evenly from hooks forward	5
Flanks, full and even with underline	3
Hooks, wide, but smooth and well covered, not prominent	4
Sirloin and rump, straight on top, long, wide, well filled between hook and pin bones, smooth	5
Pin bones, wide apart, smooth, not patchy	2
Tail head, smooth, in line with back; tail, fine, falling at right angles to top line	1
Thighs, full, deep and wide	3
Twist, full and deep, nearly as low as flank	3
Legs, straight and short; bone, flat, clean and strong	2
Total	100

THE DRAFT HORSE.

The draft horse finds his particular field of usefulness in hauling heavy loads. He is a machine, the function of which is propulsion. To best perform this work he must be heavily and strongly built. Everything about him should be massive. The draft horse should be 16 to 17 hands high. This measurement is taken at the withers. The height should be due to depth of body instead of length of leg. A deep body indicates constitution, and capacity for food, which in turn indicates capacity for work.

The draft horse should weigh 1,600 lbs. or more. This weight should be largely due to massiveness of form, heavy frame and muscles, rather than to an excessive amount of fat.



Draft type showing names and location of points.

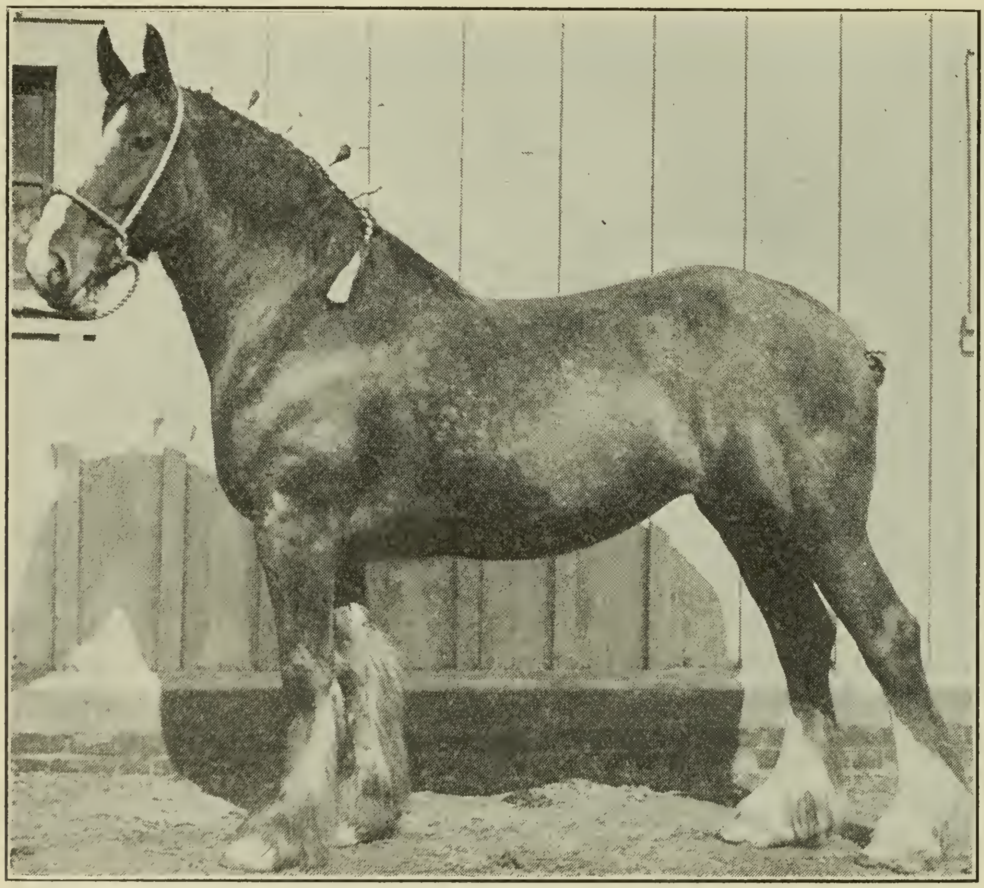
The horse market classes horses weighing less than 1,600 lbs. and of draft type as farm chunks and wagon horses. Depth and width of body, compactness, blockiness, heavy muscles are some of the things which indicate great weight. Long legs, light bones and muscles, long body with small girth at the heart and flank, and long back are some of the things which indicate that the horse is not heavy for his height and should cause you to discriminate against him in judging.

Stand at a convenient distance in front of the horse and note the form of the head, the width of breast and depth of chest, strength and straightness of fore legs. You should see a large clean cut head, bright eyes, large open nostrils, broad forehead, great breadth between the points of the shoulder, a wide breast, a pair of short, strong heavily muscled legs, squarely placed and vertical to the ground.

Standing at the side of the horse, note the upper and lower lines, the balance of fore and hind quarters, the depth of body, the muscles of the back, compactness and closeness to the ground. The body should be deep and well proportioned in all its parts, giving a well balanced appearance. The fore and hind flanks should be well filled, the back and loin strong, short and heavily muscled. The croup should carry out fairly level to the tail end.

From the rear, note the width and straightness of croup, the muscles of the thighs and quarters, and the position of the hind legs. The croup should be wide and straight, quarters and thighs heavily muscled, the legs straight and squarely placed under the body.

The value of the horse depends largely upon the quality of all its parts. From the same position as before note the flatness of bone, the cleanness and definition of the joints, fineness of hair and clean cut appearance of the head. Quality is shown by a clean flatbone, clean and well defined joints, fine hair and skin and clean cut features.

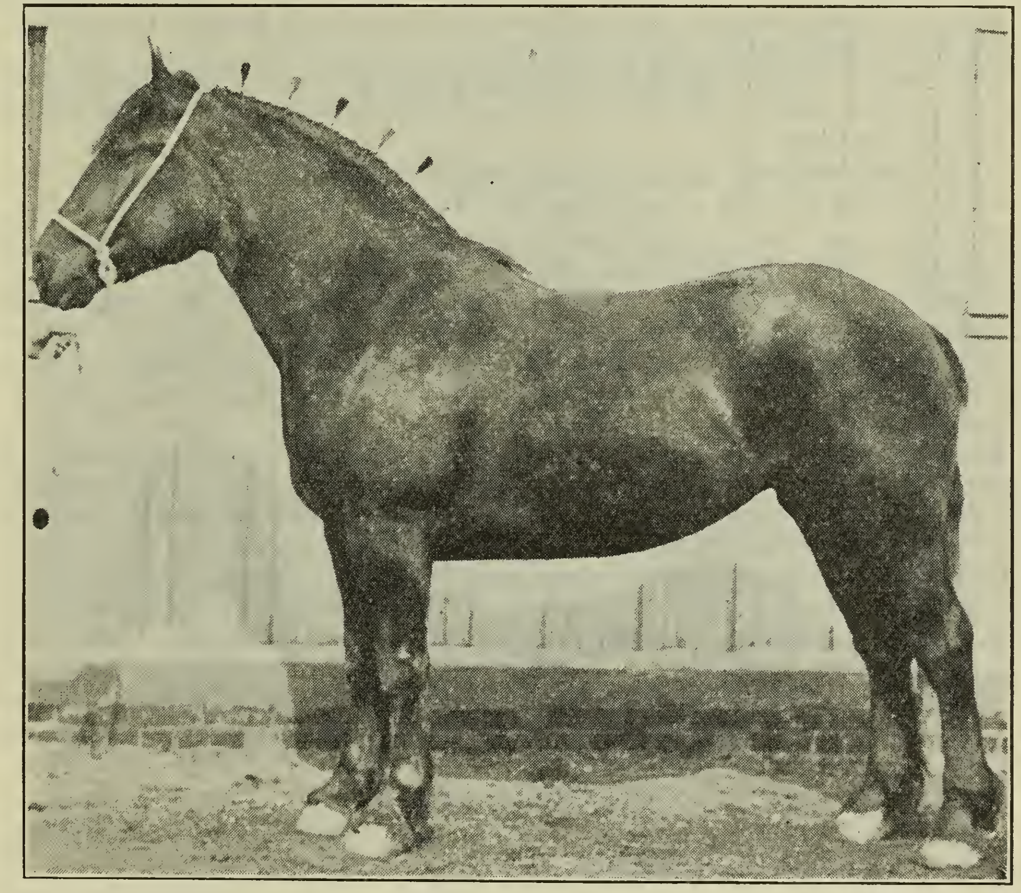


One of the Clydesdale brood mares at the Ontario Agricultural College.

A closer inspection is also necessary. The shoulder should be smooth and strong and should show an obliquity of about 45 degrees. The rough angular shoulder is more liable to become sore than the smooth snug shoulder. It should lay well back into the body. The fore arm should show a clean flat appearance and should be heavily muscled. The knee should be large, straight and angular with the tendon standing out well to support the joints. The cannons should be short and clean with the tendon well defined at the back, giving the leg a flat appearance. The fetlock joints should be clean, straight and strong. The pasterns, viewed from the side, should show a slope of about 45 degrees, about the same slope as the shoulders. The foot should be attached to the leg so that it toes straight ahead. This position permits straight forward action. The feet should be large, even in size and, from the front view, should appear nearly circular at the line of contact with the ground. The heel should be deep and broad. The hoof wall should be free from cracks or breaks.

The fore ribs should be well sprung and long, giving the horse a broad back and a deep chest. The back should be short and heavily muscled, the coupling should be close and strong, the ribs roundly arched and the flank low.

The hips should be smooth and in keeping with the general width of the horse. The croup should be wide, level and heavily muscled. Deep, strongly muscled quarters and thighs are required for strength. The gaskin or lower thigh should be short and heavily muscled. The hock should be broad, clean and flat and strongly supported below. The juncture of the hock and cannon bone should be strong and should not appear cut in. From the rear, note the back and side of the joint which should be long from top to bottom, strong, angular, strongly supported by the back tendon and free from any puffiness. With the exception that the hind cannons are usually wider, pastern and toes slightly shorter and feet less rounding the requirements are the same as the fore legs.



A three-year-old Percheron mare owned by the Ontario Agricultural College.

Action is important. View the horse as he walks away from you. His feet should be lifted with a snap, the joints flexed so that the shoe shows plainly and carried forward in a straight line. The hocks should be carried fairly close together. As the horse walks towards you his feet should be lifted clear of the ground, brought forward straight and the heel and the toe should meet the ground at the same time. This can best be determined when no dust or dirt is kicked forward by the impact.

Viewed from the side, he should move with a quick, energetic, lengthy stride with a proper flexing of all the joints. The horse should then be trotted when the same observation should be made as before.

Scale of Points.

	Possible Score
Head—Ear of medium size and pointed; forehead broad and flat; eye full, prominent and mild; nasal bones straight; nostrils large, firm and flexible; muzzle rather small; mouth of medium depth; lips compact; muscles of cheek well developed and prominent; space between branches of lower jaw wide at angles	4
Neck—Of medium length, deep and full where it joins the body, being continuous with the withers without any line of demarcation; crest nicely arched; the whole neck to be well and prominently muscled, surmounted by a good, full mane of good quality, and attached to the head in a graceful manner, not too thick and heavy at the throat	4
Withers and Back—Withers in line with the upper border of the neck, fairly high, broad and well muscled; back straight and short; loins broad, strong and heavily muscled	6
Croup—Long, level, well and prominently muscled, dock coming out fairly well up and well clothed with straight and not too coarse hair	3
Chest—Ribs long and well sprung with well marked angles; false ribs long, deep through girth; breast broad and well muscled	8
Shoulder—Oblique and heavily muscled; the muscles covering the blade thoroughly developed and prominent	4
Elbow—Strong and muscular and fitting closely to chest	1
Forearm—Large and strong; rather short and well muscled	2
Knee—Straight, deep, broad and strong	3
Knee to Foot—Cannon bone short, broad, strong, flat and flinty; ligament and tendons well developed and not too much tied in below the knee. Fetlock joint large and strong; pastern of medium length and well marked obliquely. Hair, where present, straight, fine and silky	8
Foot—Large, round, with strong and deep wall, frog well developed and strong; heels broad and strong and not too deep. There must be an absence of any appearance of hardening or thickening of the lateral cartilages. Feet must be of equal size	8
Haunch—Strong and heavily muscled, thick through thighs; quarters broad and strong	4
Stifle—Strong, compact and well muscled	2
Gaskin—Strong and heavily muscled, bone large	3
Hock—Large, deep, broad, clean-cut, and angular. Must stand with hocks fairly well together, but straight	4
Hock to Foot—Cannon bone short, broad, flat and strong; ligament and tendons well developed and strong; and not pinched in below hock; fetlock joint large and strong; pasterns of medium length and well marked obliquity. Hair, where present, straight, fine and silky	8
Foot—Smaller, narrower and more concave in sole than forefoot; wall strong and moderately deep; frog well developed and strong; heels broad and strong, and not too deep. Feet must be of equal size	8
Temperament—Energetic, docile, not nervous	4
Style and Action—General appearance attractive, movements bold, straight, true and snappy; must be a good walker, all joints moving freely; knees and pasterns and hocks and pasterns well flexed, showing the soles of the feet quite plainly, must not wing or paddle with the fore feet, must not go wide at the hocks, nor yet close enough with the feet to interfere	10
Weight and Height—Say 1,600 pounds and upwards and say 15½ hands up	6
Total	100

Note:—Colour varies in different breeds. It may be bay, chestnut, brown, black, roan or gray in Clydesdales and Shires or it may be black, gray, bay or brown in Percherons or chestnut, roan or bay in Belgians, etc. All horses should show a good coat of fine, silky hair, and a soft, smooth skin.

HORSE BREEDING CLASSES.

In judging breeding classes it is necessary to take into consideration sex character and breed character as well as draft type. A stallion should be masculine in appearance with a bold flashing eye, a good carriage of the head, a heavy development of the crest and forequarters to mark his masculinity. His conformation and disposition should be in a direct contrast to that of the mare. The forequarters, neck and head of the mare should be refined, combined with a quiet disposition to give her a feminine appearance throughout.

Certain breeds of horses have been developed to do certain kinds of work. Size, conformation, quality and action are essential to carry on the work necessary for draft horses and should be considered first in judging breeding classes. Colour, shape of head, slope of shoulder and pastern, size of feet, presence or absence of hair on the legs are breed characters and are adhered to as an indication of pure breeding. These must be given consideration in judging breeding classes.

CHARACTERISTICS OF CLYDESDALE AND PERCHERON.

CLYDESDALE—

Clydesdale breeders stress particularly quality of feet, slope of pasterns, strength and quality of bone, fineness of feathering and boldness, trueness and snap in action. No coarseness of bone or feathering should be found on a good Clydesdale. In colour they may be bay, brown, black, chestnut, roan or gray.

PERCHERON—

The Percheron has a distinctive head which is fairly large with a broad forehead, a straight or slightly dished face and ears of medium length. Good representatives of the breed conform closely to the requirements of the draft horse. There should be an absence of feathering on the legs. As a breed they have a deep heart girth, are strongly coupled up and heavily muscled. In colour they are generally black or gray although some chestnuts, bays and browns do occur.

HARNESS HORSES.

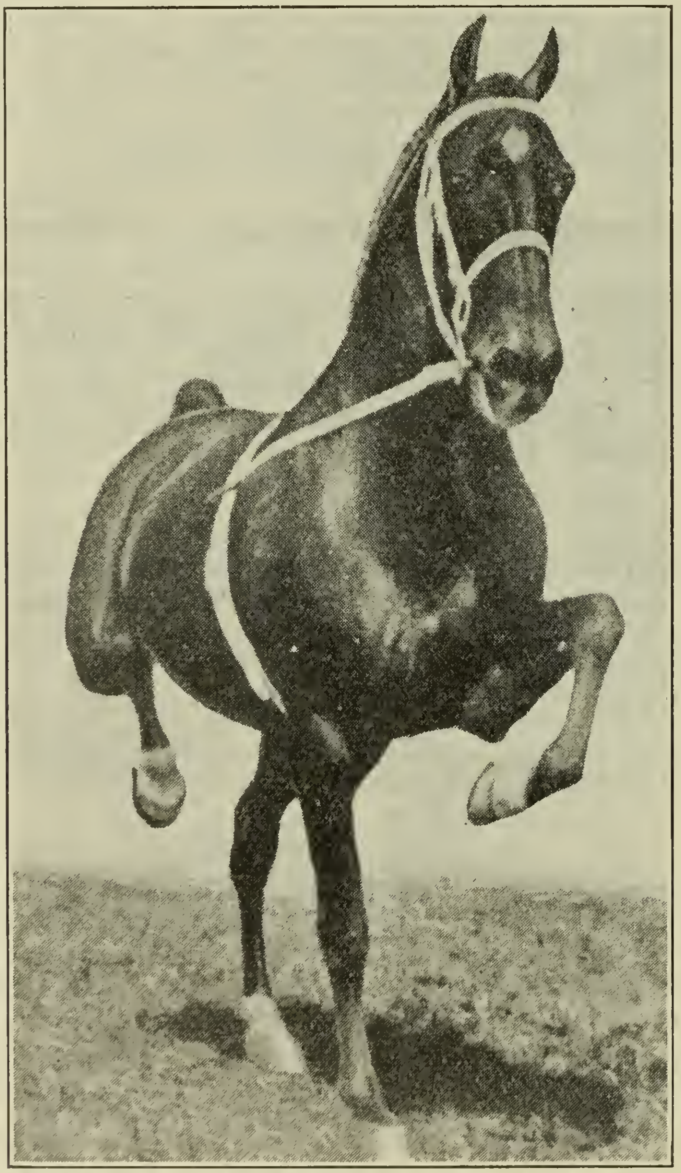
After becoming familiar with the points of the horse and having made a careful study of the draft horse, it will be an easier matter to learn to judge the other classes of horses. All the parts are named the same. Indications of quality, constitution, etc., and methods of making observations and examinations are the same. Differences which fit horses for particular kinds of work cause them to be classified differently.

Harness horses are generally divided into two classes, the heavy and the light. The heavy harness classes include horses of the coach type which are driven at a slow pace to a heavy vehicle. The light harness class is made up of horses of the roadster type which are driven to a lighter vehicle at a faster, less stylish gate.

HEAVY HARNESS HORSE.

The heavy harness horse is fairly compact, smoothly turned and has a high flashy action. It varies from 15 to 16 hands in height and from 1,100 to 1,400 pounds in weight. The head and neck should be clean cut and carried high and gracefully. The shoulders and pasterns should be oblique and the knees and feet strong and free from any unsoundness. The back should be short, the ribs well sprung and deep, the croup long and level, the quarters and gaskin should be heavily muscled, the hocks clean and large, and the feet of medium size.

The heavy harness horse should be of good quality in order that it may have the appearance of refinement which is absolutely essential to horses of this class. Action is the most important quality of the harness horse. All movements should be graceful and in proper balance. The fore feet must be carried high and straight; the hocks should be sharply flexed and the hind feet kept well under the body.



A Hackney horse in action.

SCALE OF POINTS.

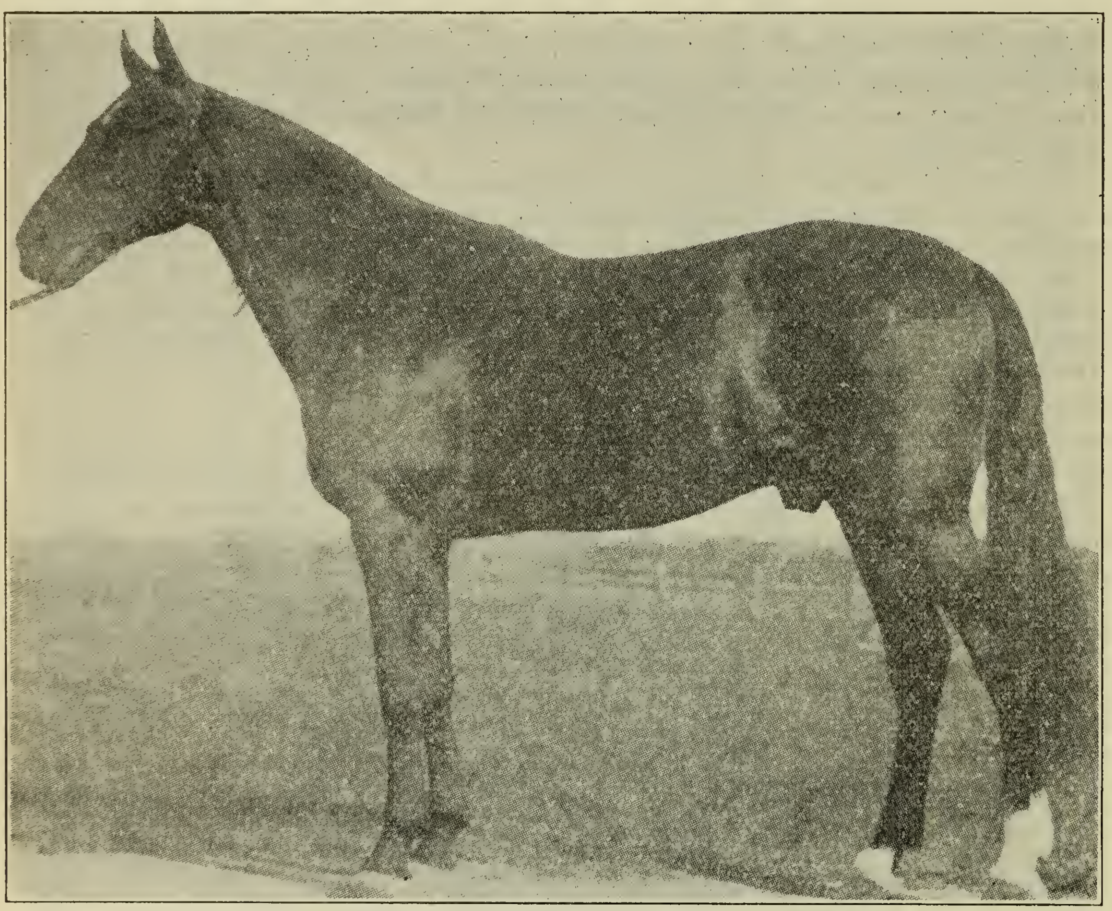
	Possible Score
Head—Ears rather small, set wide apart, fine and turned inwards at tips; forehead broad and flat; eyes full, clear, prominent and mild, but lively in appearance; face straight in front and slightly dished laterally; nostrils well developed, firm and flexible; mouth rather small, muzzle fine; lower jaws not heavy but wide apart at angles; cheeks flat and well clothed with well developed, hard but not bulky muscles; head carried fairly high, with ears in an attractive position; nose drawn slightly towards chest	4

Neck—Of medium length, crest nicely arched, hard and whipcordy; clean cut, not too coarse at throat, attached to head in a graceful, angular manner	4
Withers and Back—Withers high but not too sharp; back short and strong, loins broad, full and muscular	6
Croup—Long and level; tail coming out rather high up and carried straight and well out from the body in a graceful manner	3
Chest—Ribs long and well sprung, with well marked angles; false ribs well developed; deep through girth; breast wide, with well developed muscles standing out prominently	8
Shoulder—Oblique, deep and well muscled	4
Elbow—Well muscled, strong and lying close to chest	1
Forearm—Long, muscles well developed and well defined, and extending well down the limb	2
Knee—Straight, broad and deep with an absence of malformations	5
Knee to Foot—Cannon bone short, broad, flat and clean; ligament and tendons standing out plainly; tendons not too much tied in below knee; fetlock joint large and strong; pasterns strong and of medium length and obliquity	5
Foot—Rather large, round and strong, concave sole, well developed frog; heels broad, strong and not too deep; must not turn toes either inwards or outwards when standing and the feet must be of equal size	8
Haunch—Heavily muscled, thick through thighs	4
Stifle—Strong, compact and well muscled	2
Gaskin—Strong and heavily muscled, muscles extending well down the limb	3
Hock—Strong, clean, angular, rather short, an absence of coarseness or puffiness; point well marked and rear border straight	5
Hock to Foot—Cannon rather short, flat and clean; ligament and tendon standing out prominently and not tied in below the hock, skin lying close to bone and tendon, no long hair, fetlock joint large and strong; pastern strong and of medium length and obliquity	5
Foot—Smaller and not as round as fore one, sole more concave, frog well developed, heel broad and strong, and not too deep; the feet must be of equal size	8
Action—Shoulder, elbow, knee and pastern action in fore limbs, and hip, stifle, hock and pastern action in hind limbs, must be free and easy. Knee and hock action must be high, pasterns must be well flexed, showing the soles of the feet plainly; shoulder well thrown forward, giving considerable extension to the tread, with style, grace and speed, the fore feet brought high up towards the elbow. The horse must neither paddle nor roll with the front feet, but fetch them up and forward in a straight line, with grace, promptness and style; hind feet must be lifted promptly and high, with great flexion of hock. All feet carried straight with a good long stride, and planted firmly but lightly. Stylish, high and bold, free action must be shown whether jogging or going fast, and the faster the better	15
Temperament—Docile, but very energetic, free from nervousness, general appearance attractive and stylish	4
Weight and Height—Say 1,100 to 1,400 pounds (stallions up to 1,500), and say 15 to 16¾ hands	4
Total	100

NOTE:—Best colours are bay, chestnut, brown and black; roan and gray are not so popular. Skin and hair should be fine and smooth.

THE LIGHT HARNESS HORSE.

The light harness horse is more rangy with lighter and longer muscles than any of the other types. Its purpose is to move light vehicles at a rapid rate for a greater or lesser period of time. The roadster must have stamina, good constitution and a good disposition. The most desirable size is 15½ hands high and 1,100 pounds in weight. The head should be medium in size with a clean cut appearance with full, bold eye and erect medium sized ears. The neck should be clean cut, long and slightly arched. A sloping shoulder should extend well into the back. The body should be deep, closely ribbed and strongly coupled, the croup level and nicely rounded with muscles. The muscles of the thigh, quarter and gaskin should be long and heavy. The action of the roadster should be moderately high. The feet should be carried straight forward and a long easy stride should be in evidence.



A Standard Bred Stallion showing the light harness type.

SCALE OF POINTS.

	Possible Score
Head—Ears of medium size and tips pointed towards each other; forehead broad and flat; eye, large, prominent and docile in expression; bones of nose straight in front and slightly dished laterally; nostrils firm, large and readily dilated; muscles of cheek well developed, but not too bulky; lips firm; mouth of medium depth; muzzle fine and tapering; branches of lower jaw well spread at angles	4
Neck—Rangy, with crest well developed, hard and whipcordy; neck attached to head in a graceful angular manner; clean, but not too fine in the throat; wide and muscular at the shoulder	4
Withers and Back—Withers fairly high generally showing a little above the general outline. well developed but not too broad; back straight and short, loins broad and well muscled	6
Croup—Rather long, somewhat sloping, with dock coming out high up. Dock carried straight and well out from the body in a graceful manner	3
Chest—Deep through girth; ribs long and well sprung with well marked angles; breast broad and heavily muscled	8
Shoulder—Oblique, blade bone well muscled	4
Elbow—Well muscled, and lying close to chest	1
Forearm—Long, well developed and strong, muscles well deveoped and extending well down the limb	2
Knee—Straight, clean, deep, broad, and strong; free from malformations	5

Knee to Foot—Cannon bone short; broad, flat and clean; tendons and ligament well developed and prominent and not too much tied in below the knee; skin lying close to bone and tendons; fetlock joint strong; pasterns strong and of medium length and obliquity	5
Foot—Of medium size, rather round, with strong wall of medium depth; sole slightly concave, frog large and well developed; heels broad and strong, and not too deep; must not turn toes either inwards or outwards when standing; and the feet must be of equal size	8
Haunch—Muscles well developed, deep through thighs; quarters broad and strong	4
Stifle—Strong, compact and well muscled	2
Gaskin—Muscles prominent, hard, and extending well down the limb; ham string prominent and whipcordy	3
Hock—Large, strong, deep, broad and angular; all parts well developed, an absence of coarseness, malformation and puffiness; point well developed; rear border straight	5
Hock to Foot—Cannon bone short, clean, broader and flatter than in front, tendons and ligament well defined and prominent, and not pinched below the hock; skin lying close to bone and tendon; fetlock large and strong; pasterns strong and of medium length and obliquity	5
Foot—Smaller and not as round as in front; sole more concave, frog well developed, heels strong and not too deep; the feet must be of equal size. Toes should turn slightly outwards when standing	8
Temperament—Kind, docile, prompt, energetic, not vicious	4
Style and Action—Appearance stylish and attractive; action free and elastic; good walker; may either trot or pace, must be perfect in which ever gait he takes; must not paddle or roll his front feet, may go wide behind to a limited extent, must not go close enough to interfere, must go level without hitting himself in any place, and be able to go fast and show endurance	15
Weight and Height—Say 950 to 1,200 pounds and say 15¼ to 16 hands	4
Total	100

NOTE:—Any one of the following colours is not objectionable: bay, chestnut, brown, black, roan and gray with or without white markings. All horses should show a fine coat of hair and a soft smooth skin.

SADDLE HORSES.

There are several quite distinct types of horses that do work under the saddle. They are commonly divided into two classes in this country, namely, saddle horses and hunters or jumpers.

The saddle horse varies in size and weight according to the weight to be carried. The quality, set of leg and conformation in general are slightly similar to that of the carriage horse. A greater emphasis, however, is placed upon the length of neck, slope of shoulder, height at withers, and length of pasterns than in any other class of horses, thus ensuring more comfort and endurance to the rider and the horse. In action, the saddle horse should show a brisk, easy walk, should be able to canter gently and to trot with a steady, straight and true stride.

Saddle horses are sometimes classified, according to their gait, into two classes: first, the three-gaited, and second, the five-gaited saddle horse. The three gaits mentioned in the first class are the walk, trot and canter, and in the second class these three with the addition of the running walk or slow pace and the rack.

Jumpers or hunters are saddle horses trained to jump. This ability counts a great deal more than the conformation of the horse. Horses in this class are often larger and show less refinement than the purely saddle horses.

Scale of Points.

	Possible Score
Head—Ears fine, of medium size and pointed, movement lively, and approaching each other at tips when pointed forward, not lopping; forehead broad and flat; eyes wide apart, prominent, large and bold in expression, lively, but not vicious in appearance; nasal bones straight in front but slightly dished laterally; nostrils firm, large and flexible, of large capacity when the animal is excited; lips firm; mouth of medium size; muzzle small and tapering; cheeks well, but not heavily, clothed with hard, well developed muscles, branches of lower jaw well spread apart at angles	4
Neck—Clean cut and rangy, crest well developed and whipcordy, but not heavy; head attached to neck in a graceful, clean cut manner; throat not thick and heavy	4
Withers and Back—Withers high, rather thin, and sloping gradually to the back; unless the animal be very fat there should be a line of demarcation where the neck ends and the withers begin; back straight and short; loin broad, strong and well muscled	9
Croup—Long and fairly level, with dock coming out high up, and carried straight and well out from the body in a graceful manner	3
Chest—Somewhat broad at base with apex between the shoulders. The muscles of the breast should be well developed and prominent in front, and the chest should be deep from above downwards, especially at the girth; ribs long and well sprung, with well marked angles	8

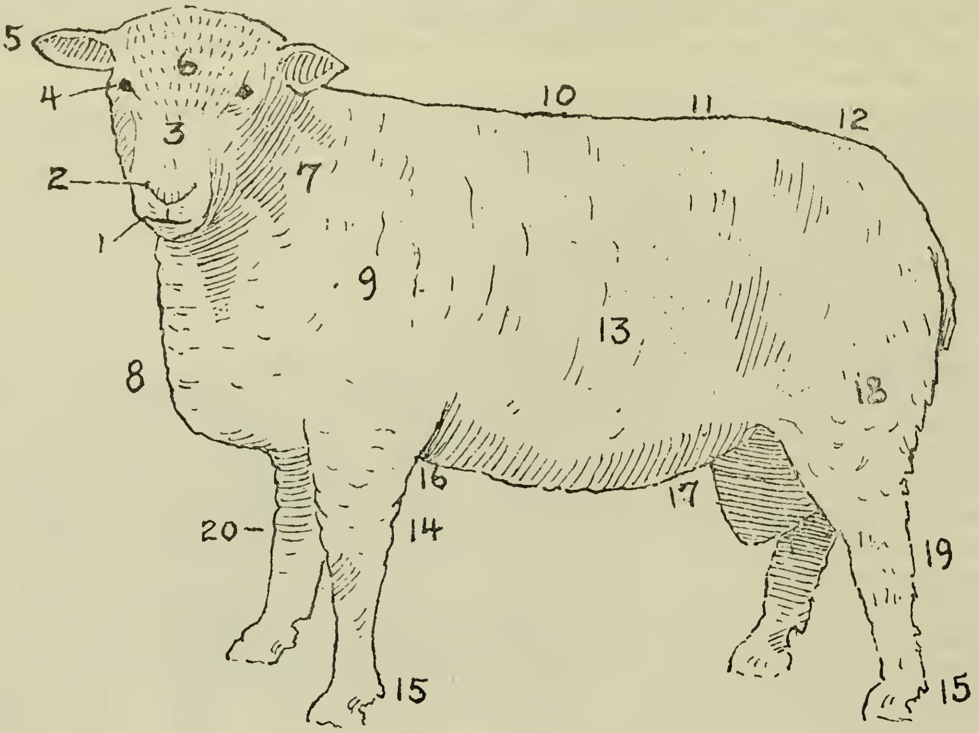
The Thoroughbred Stallion, McNeil. The blood of this breed is found in all saddle horses.

Shoulder—Oblique and having the blade covered with hard, well developed muscles	4
Elbow—Well muscled and lying close to chest	1
Forearm—Long, well developed, strong and muscular, showing the outline of each individual muscle	2
Knee—Clean, straight, large and strong, not inclined to be either knee-sprung or calf-kneed	5
Knee to Foot—Cannon short, broad, flat and clean, tendons standing out plainly, hard and whipcordy, lines of demarcation between tendons and ligament and between ligament and bone, well marked. Not too much pinched below the knee, fetlock joint well developed and strong, pasterns somewhat long and of medium obliquity	5
Foot—Smaller in proportion than in other classes of horses; rather round, strong, with deep wall, sole concave, frog well developed, heels full, wide, and not too deep; must not turn toes either in or out when standing. Feet must be of equal size	8
Haunch—Strongly muscled, showing grooves of demarcation between muscles, quarters broad and strong	4
Stifle—Strong, compact, and well muscled	2
Gaskin—Well muscled, extending well down the limb	3
Hock—Deep, broad and strong with an absence of roughness, puffiness and malformations; point very well developed; straight on rear border; the whole joint clean, strong, hard and angular	5
Hock to Foot—Cannon short, wider and flatter than in fore legs, clean, no feathering, tendons well marked individually; not having a pinched appearance below the hock, but very gradually tapering in width from hock to fetlock; fetlock joints large, clean and strong, pasterns rather lengthy, strong and of medium obliquity	5
Foot—Smaller and not as round as front feet, sole more concave, frog well developed, heels strong, broad, and not too deep. Feet must be equal size	8
Temperament—Mild, not vicious, energetic, inclined to be impetuous, but not too nervous	4
Action—Prompt, free and elastic, free shoulder action, not too much knee or hock action, but going rather close to the ground especially at the canter or gallop. Must not paddle or roll front feet or go close enough behind to interfere, neither may he go wide behind; must be a good walker	12
Height—Say 15½ to 16½ hands	4
Total	100

NOTE:—Best colours: bay, brown, chestnut, black or gray. Skin and hair fine and smooth.

SHEEP.

Types of Sheep.—All sheep may be divided into two classes, mutton and fine wool. Mutton sheep possess those characteristics which lend themselves to the economical production of meat for the market with wool as a secondary factor. Fine woolled sheep, on the other hand, are bred for the production of wool as a primary consideration with mutton as a secondary factor.



Points of Mutton Sheep.

1. Mouth
2. Nostril
3. Face
4. Eye
5. Ear
6. Forehead
7. Neck
8. Breast
9. Shoulder
10. Back
11. Loin
12. Rump
13. Middle
14. Fore Leg
15. Pastern
16. Fore Flank
17. Rear Flank
18. Leg of Mutton
19. Hock
20. Knee

Keeping in mind the purposes for which these two types are bred it is not difficult to appreciate a considerable variation in appearance. The mutton type has the form of a meat producing animal. It is broad, blocky, low set, parallel and straight lined, full in the twist, deep and evenly fleshed. It has a rotundity and fullness of form, compactness and smoothness, coupled with a stylish appearance. The fine wool type is rather light bodied, not so straight topped, sharp at the shoulder tops, lacks filling in the twist and thin in flesh. The skin of the fine wool type is more or less wrinkled and carried in folds. The fleece is very much finer in quality, more compact, and carries considerably more yolk than that of the mutton type sheep.

With very few exceptions the sheep found on the farms of Ontario are of the mutton type. This is due to the increased demand for mutton, which has occurred in recent years, and the adaptation of this type to farming operations where small flocks are maintained.

Classification of Mutton Sheep.—The various breeds belonging to the meat producing class although varying more or less in type all possess general characteristics that stamp them as mutton sheep. A general classification of the breeds of mutton sheep is made according to fleece, the two classes being commonly known as the *medium wool breeds* and the *coarse or long wool breeds.*

The sheep belonging to the medium wool breeds possess somewhat finer and denser wool than the coarse or long wool breeds while the colour of the hair on the face and legs generally varies from a light to a dark brown. Together with good quality of wool sheep of this class are recognized as possessing pronounced mutton type. The breeds belonging to this class are as follows: Shropshire, Southdown, Oxford Down, Hampshire, Suffolk, Dorset Horn and Cheviot. With the exception of the Dorset Horn and occasionally the Cheviot all these breeds are hornless.

Mutton type.

The long or coarse woolled breeds are characterized by having a much longer, coarser fleece, lacking, as a rule, the density found in the medium wool breeds. They are usually somewhat heavier and possibly a little more upstanding and most of the breeds belonging to this class have white or mottled faces. The long or coarse woolled class is represented by the following breeds: Leicester, Lincoln, Cotswold and Romney Marsh. All of these breeds are hornless.

The wool type or fine wool class is represented by the American Merino, Delaine Merino, Rambouillet, Corriedale, and Karakule. While the aforementioned breeds are of considerable importance in many countries, owing to the fact that very few are being bred in Ontario, their characteristics will not be outlined in this bulletin.

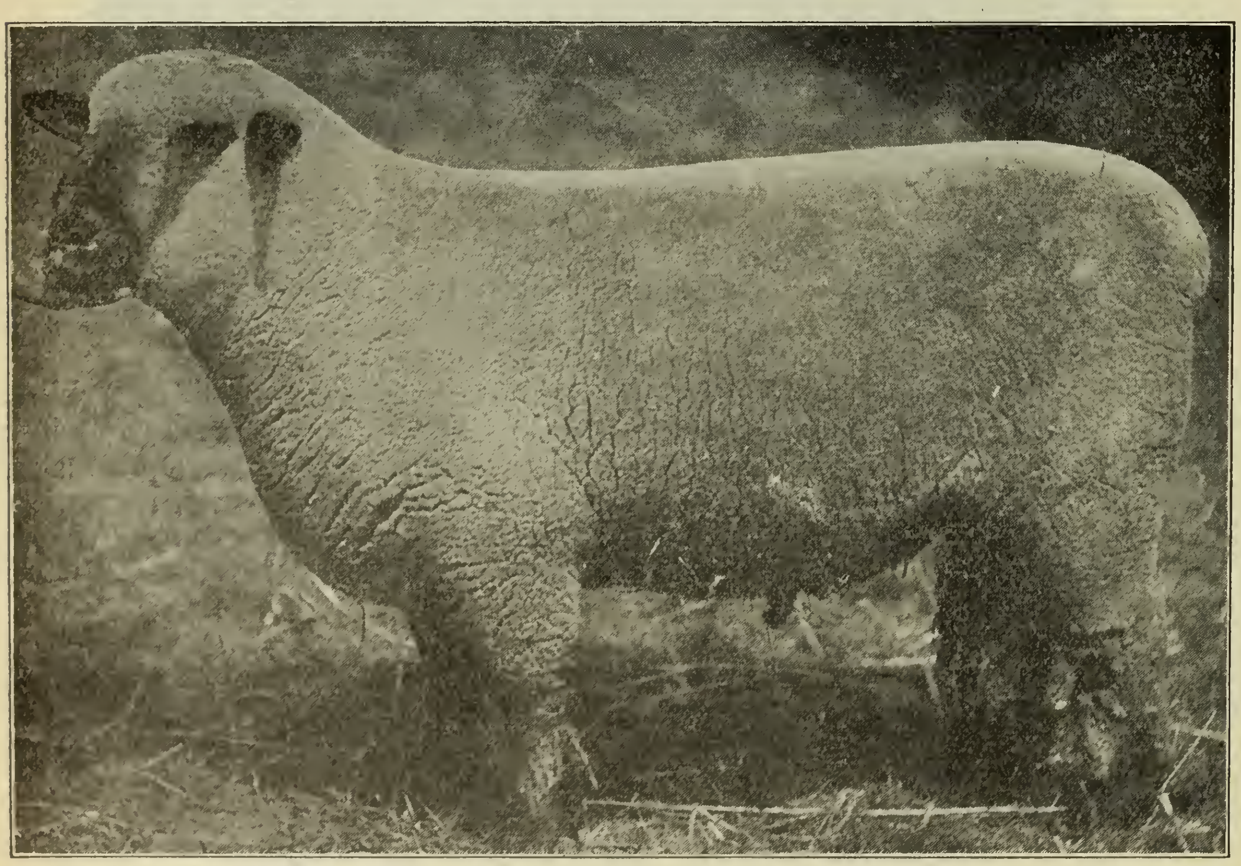
CHARACTERISTICS OF THE MUTTON TYPE BREEDS.

SHROPSHIRE—

In general appearance the Shropshire conforms to what is recognized as excellent mutton type. It is somewhat heavier than the Southdown, rams weighing at maturity about 225 lbs. and ewes about 160 lbs.

A trio of Shropshires.

The head is covered with dense wool, which should completely cover the entire face excepting a small part of the nose. The legs are also well woolled. The colour of head and legs is usually a dark brown, being considerably darker than those of the Southdown. There should be an absence of black wool on the head. The wool is reasonably compact, of good quality, medium fine, and should be free from black fibres. It is longer than that of the Southdown but shorter than the Oxford, being about three and one-half inches in length. The skin should be a bright pink.

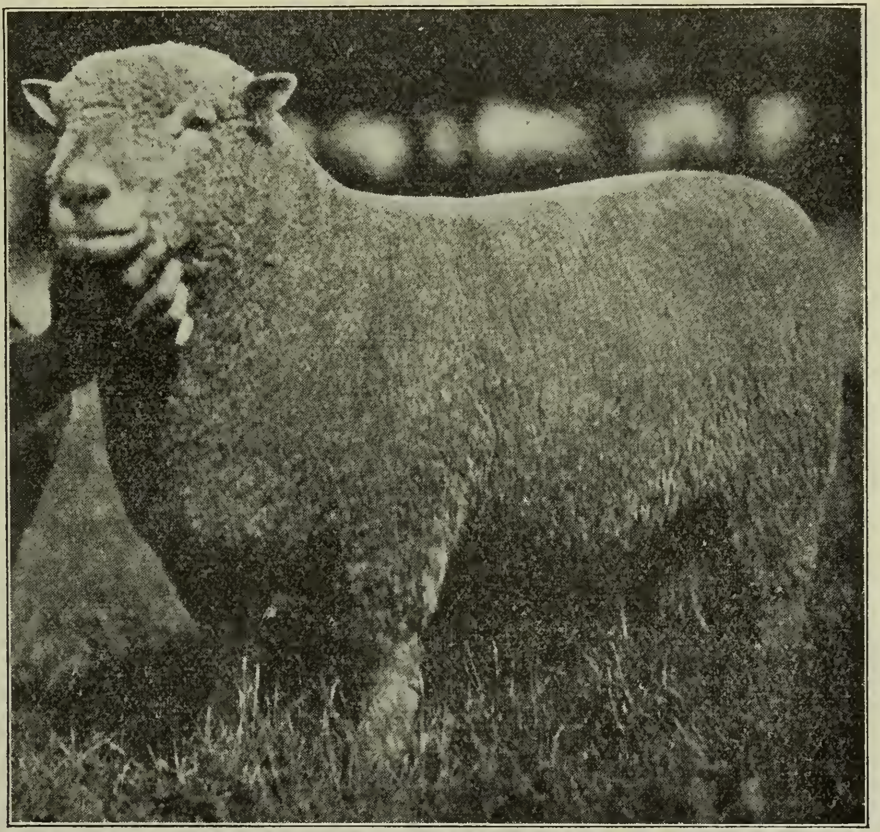


Hampshire ram.

Hampshire—

The Hampshire is the second largest of the medium woolled breeds, being surpassed only by the Oxford. Mature rams should weigh around

250 lbs. and ewes 190 lbs. The head is woolled to a point just below the eyes and on the cheeks, the colour of both head and legs being a dark brown bordering in some cases to black. The ear is long and droops somewhat, the head large and inclined to be rather Roman-nosed. As regards wool the Hampshire shears a fleece of medium length and quality, but lacks the quantity reasonably expected from sheep of its weight.



Southdown ram.

SOUTHDOWN—

They are the smallest of the down breeds, the mature ram weighing about 175 lbs., the ewe 135 lbs. The shortness of leg, compactness of form and general smoothness of outline give this breed an advantage as they weigh well for their appearance, and what they lack in size is made up, in part at least, by their excellent quality as the mutton of this breed has always held a premier place on the largest markets and with the most discriminating mutton consumers. A blocky, compact, well-rounded form is characteristic of the breed, and this, together with the fact that the present day demand is for a light lamb, is a reason for believing that this breed will grow in popularity in Ontario. The head is covered with a cap of wool which should extend below the eyes. This, as with the wool covering the legs, is a greyish-brown or mouse colour. The wool is of fine texture, should be dense all over the body, averaging possibly two and one-half inches in length. Associated with this the skin should be a bright cherry pink.

SUFFOLK—

The head is fairly long, distinctly black in colour and the wool does not cover the head beyond a point behind the ears. The ears are rather large and the same colour as the head and legs. In size the Suffolk ranks between the Shropshire and Hampshire, the rams weighing around 230 lbs. and the ewes about 180 lbs. The Suffolk Down is a mutton sheep, ranks high, the infusion of the Southdown blood giving it a high quality of flesh. In regard to fleece, this breed is only fair, the wool is of good quality, being reasonably fine, but the breed is said to be a comparatively light shearer.

DORSET HORN—

The outstanding feature of this breed is that they are horned (both sexes), those on the male curving backwards and around spirally, while those on the ewe curve downwards and slightly forward. The face and legs are white; the same is true of the hoofs and nose. There is a cap of wool on the head which should extend down to the eyes. This breed does not always exhibit the fullness and compactness of form found in some other breeds of the medium wool class, but the best specimens of the breed conform fairly well to mutton type. In size the Dorset is about the same as the Shropshire, mature rams weighing around 225 lbs., the ewes about 165 lbs.

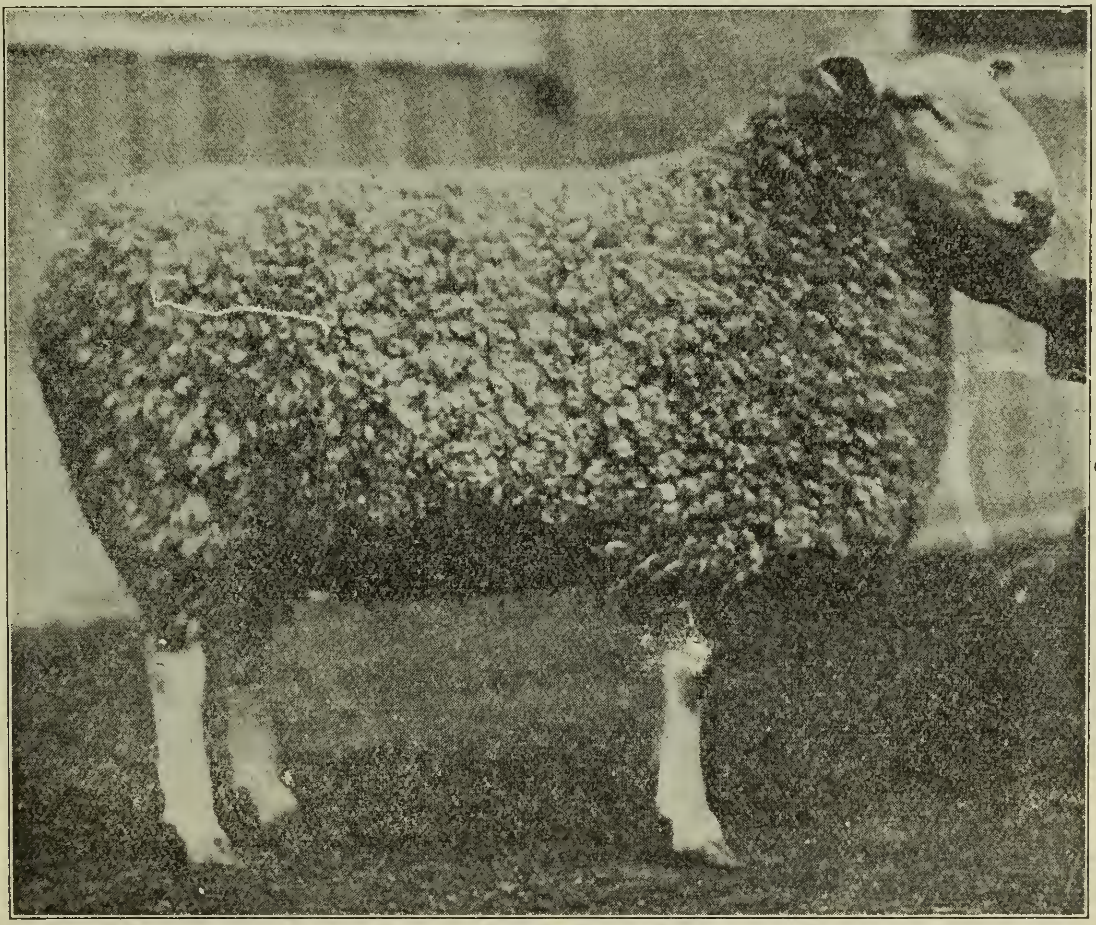
CHEVIOT—

The head is free of wool, being covered with white hair. The face is inclined to show a Roman nose not unlike the Leicester. It is not uncommon to find horns on the rams. The Cheviot is medium in weight, the rams often reaching 225 lbs. or more, while the ewe will average 160 lbs. The fleece has been said to lack compactness, although within recent years more attention has been given to the question of density of the wool.

Oxford ram.

OXFORD DOWN—

In some respects this breed resembles the Shropshire. They have, however, more scale, being the largest of the medium woolled breeds. Rams weigh 275 lbs. when fully developed, and 200 lbs. is not uncommon for ewes. The wool covering of the head does not extend below the eyes, nor is it as dense as with the Shropshire. The colour of the head and legs is usually a uniform dark brown. The ear is inclined to be larger, the face longer, and the entire head lacks the general refinement found in the Shropshire. The fleece is longer and coarser than in the other down breeds, but withal is usually of good quality and the sheep shears a heavy satisfactory fleece.



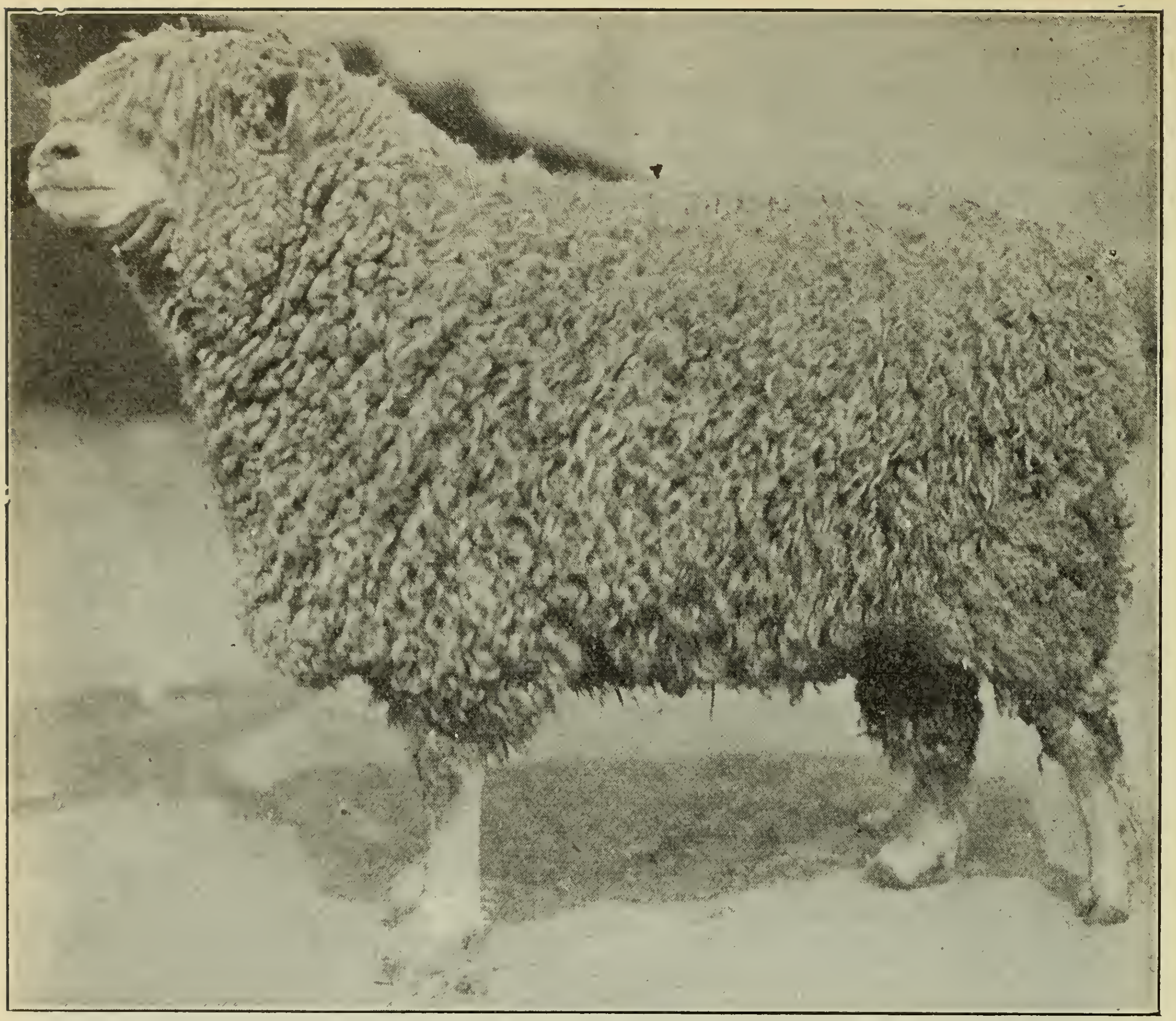
Leicester ram.

LEICESTER—

The general impression of the Leicester is that they are inclined to be long in the leg, the fact that their legs are absolutely bare of wool possibly tends to exaggerate this. They are comparatively broad in the back and carry out a full, level rump. There is an entire absence of wool on the head, which is covered with short, fine, white hair, the skin often showing a slight bluish tint. A tendency towards a Roman nose is quite common in this breed. Black spots on the head, if not too large or too numerous, are not objectionable. The Leicester shears a real good fleece of long wool. This breed is possibly the smallest of the long wool breeds, rams weighing from 225 to 250 lbs., and the ewes as much as 200 lbs.

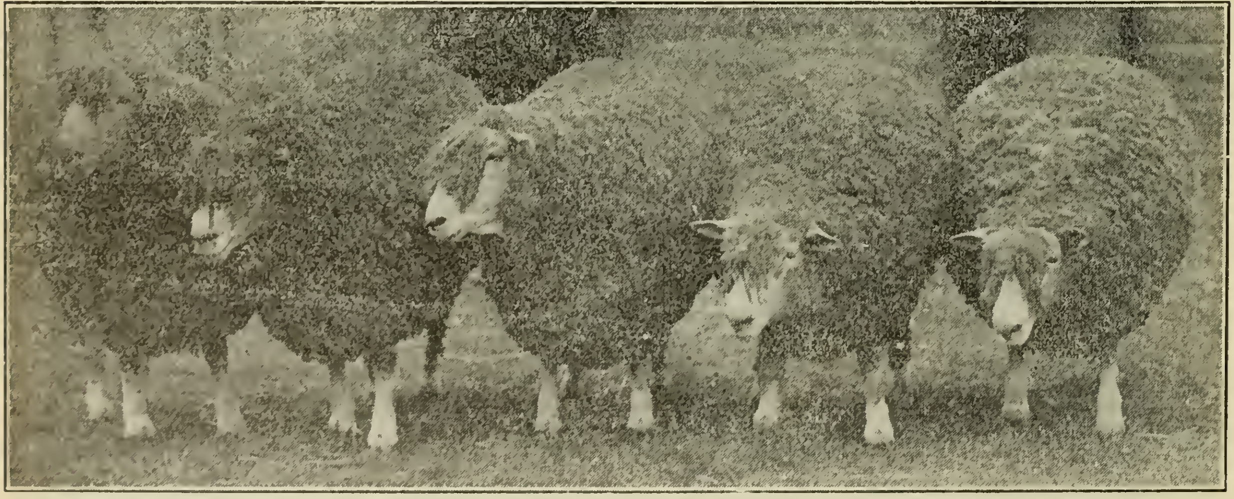
COTSWOLD—

The head of the Cotswold has a tendency to be Roman-nosed and is covered with wool that hangs in long ringlets from above the eye, spreading out over the face. The legs are also woolled to below the knees and hocks. The hair on the face and head may be either white or mottled with brown. The wool is comparatively coarse and long, and hangs in locks or ringlets over the body; the fleece is usually parted down the back, falling away on either side. This is a large breed, mature rams often reaching a



Cotswold ram.

weight of 275 lbs. and the ewes from 200 to 230 lbs. The Cotswold is a stylish sheep, possessing a bold, graceful carriage, and this with the characteristic wool covering of the breed gives it a very attractive appearance.



Five Lincoln shearling rams.

LINCOLN—

Like the Leicester and Cotswold, the Lincoln is inclined to have a Roman nose. The face is usually white, although may have brown spots. A small foretop of wool is found on the head and the wool on the body is comparatively long and coarse, hangs in ringlets, and is usually parted down the back. The Lincoln shears a very heavy fleece of wool. A weight of from 20 to 25 lbs. of unwashed wool has been known in case of mature rams. In common with some others of the long wool breeds the Lincoln may be criticized for too great length of leg, but the back is broad and the rump level and full. The Lincoln is the largest of the long wool breeds, 300 lbs., being the standard weight for mature rams, and the ewes weigh close to 275 lbs.

ROMNEY MARSH—

In general appearances this breed resembles the Lincoln, although lacking the extreme size of the Lincoln. The face is white and usually covered with a short cap of wool. They shear a good fleece of average weight.

THE MARKET LAMB.

Practically all the fat sheep which go to market to-day are lambs, the most popular weight of which is 80-90 pounds. This is because of the consumer's demand for lighter cuts and tender meat. The type of lamb for which a butcher will pay a higher price is one which will dress a high percentage of carcass to offal; the carcass must be heavy in the high priced cuts compared with the cheap cuts; the cuts must be of a size to satisfy the demands of the consumer and the carcass must be such that the meat will be fine grained, tender, juicy and well flavoured. This means a blocky, low set neat type of lamb possessing quality and finish. He should be especially well covered on his top, broad and deep loined with a uniform width throughout, heavy in his leg, light in his pauch, smooth about the shoulders and have just a sufficient length of neck to give the lamb a balanced appearance. Good market lambs usually dress from 48 to 52 per cent.

METHOD OF INSPECTION.

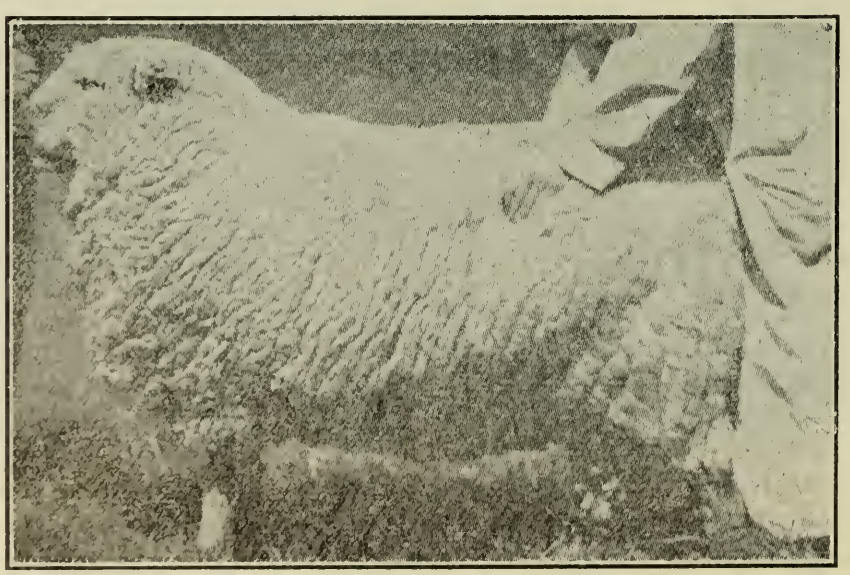
The first step in judging sheep, whether a fat or breeding class, is observation with the eye at a distance of about ten feet. Each animal should be viewed critically from the front, side and rear, noting his general type, lines and the way he stands on his legs. From in front one should note the type of the head, width of breast, and width between the front legs. From the side, the carriage of the head, the length of neck and legs, the depth of body, and general straightness of lines can be observed. The width of body, fullness of twist, and manner of standing on his hind legs may be seen from the rear. While viewing a sheep from a distance it is well to remember that the short and broad head, the short neck and short legs well set apart usually go with a thick body. It is also well to keep in mind that a shepherd who is skilful with shears can trim and block out a badly shaped sheep to look like a real good animal when viewed from a distance.

Because of their wool covering more dependence must be placed on the hand while judging sheep than with any other class of animals. Consequently, it is important that the beginner follow some definite method or system of detailed inspection.

After viewing a class of sheep from a distance a more detailed examination with the hand to discover defects in fleshing and to ascertain more definite information of the conformation of the sheep is the next step. During this procedure the hand should be *kept open,* the fingers *extended* and *together.* Standing on the left side of the sheep and fairly

Note width of chest, covering and smoothness of shoulders, fullness of the crops, and size of hearth girth.

Feel top of the shoulder for compactness. Moving the hand back in a flat position, note strength and straightness of top line to end of body, and evenness, thickness, and firmness of fleshing.



Judge width, length, thickness and firmness of flesh of loin.

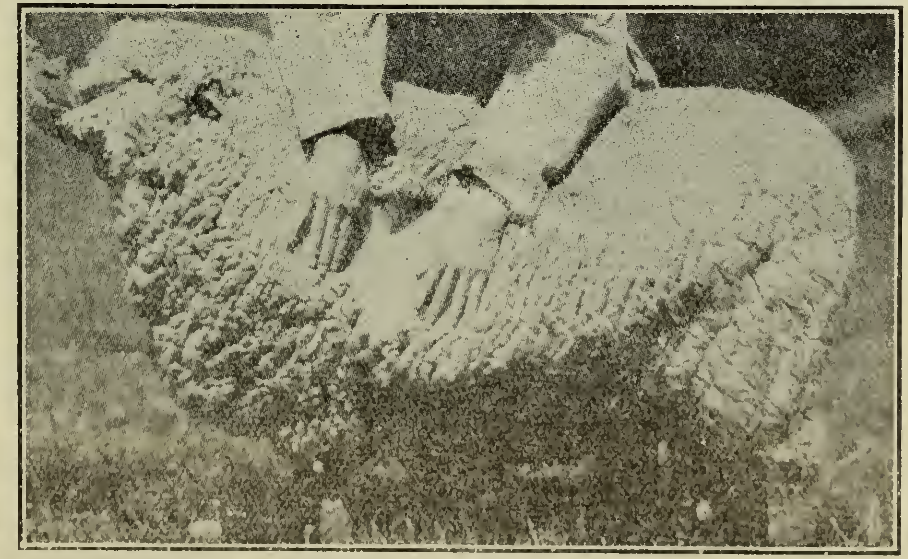
well back, with the right hand examine the top line from the neck to the dock for smoothness of conformation, for the depth, evenness, firmness and quality of fleshing along with the straightness and strength of top. Then, by means of both hands determine the length and thickness of neck, the compactness and the covering on the shoulders, the filling behind the shoulders, the spring and depth of rib, the width, depth and length of loin, the width of the rump, the firness of fleshing at the tail head and the general thickness through the buttocks.

Standing once more at the front end of the sheep with one hand on the top of the shoulders note the extension forward of the breast and the depth and width of the chest floor. The depth and fullness of the twist and size of leg of mutton should then be determined, the latter being most readily accomplished by allowing the finger tips to meet on the inside of the leg as close up to the body as the flank will permit and noting the distance between the thumb ends on the outside. Finally, to confirm your first impression concerning fleshing it is often times wise to once more examine the top covering of the sheep.

JUDGING BREEDING SHEEP.

The animal used for breeding purposes must have all the excellence of size, form, quality and condition of the market lamb or sheep, and in addition must be strong in constitution, conform to the type of the breed of which it is a representative and show pronounced sex characteristics. Moreover, when judging breeding classes consideration must be taken of the fleece in addition to what has been outlined in connection with the market lamb. True, it is that the fleeces of the different breeds vary considerably. Familiarity with breed characteristics common to fleeces is about the only means of becoming efficient in judging sheep in this respect. However, the general principles as outlined are applicable to every case.

Examining the Fleece.—To examine the fleece it should be opened in straight parts at two points, on the side of the shoulder fairly well toward the point and down the thigh in as good a light as possible. The coarsest wool is usually found on the lower part of the thigh and the best quality



Manner and place of opening fleece to examine the densest and finest quality of wool. Note also color and condition of skin.

on the shoulder. Occasionally, one is well repaid for making a third inspection on the ribs where the wool is usually about the average of the fleece. The more uniform the fleece throughout in every respect the better. One can also see the colour of the skin during this part of the fleece examination.

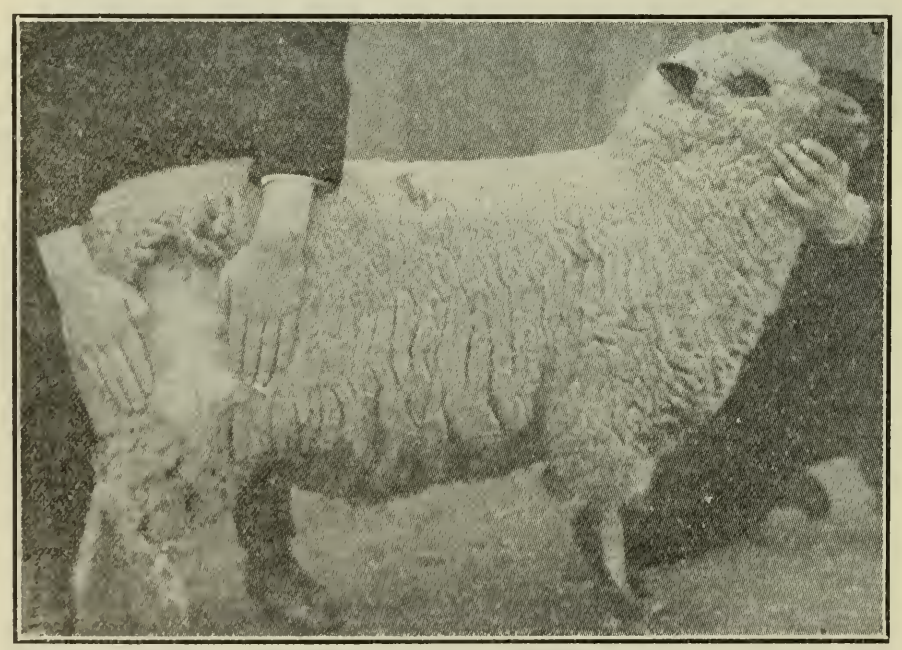
The three main features to consider in examining the fleece are quantity, quality and condition.

Quantity of Fleece.—Quantity of fleece is determined by the length and density and the uniformity of these two characteristics. Length of staple is of much importance. The variation in the length is principally due to breed although there is also much variation in length of the different parts of the same fleece.

Density of fleece means the closeness and compactness of the fibres or the number of fibres per square inch on the body of the sheep. The density of a fleece may be determined in a comparative way by noting to what extent all the wool which one can grasp fills the hand. Density is associated with weight. Moreover, if the fleece is not dense you are justified in looking for weak spots in the fibre although you may not always find them.

Quality.—Quality is determined by the fineness of fibre, soundness, closeness of crimp, softness of fibre, colour and freedom from black fibre. The short wools are usually the finest quality wool while the long staple wools are coarser. This point should be taken into consideration when judging sheep of different breeds. Fineness refers to diameter of fibre.

One of the worst faults in wool is the presence of kemp, which is short, thick, opaque, fibre, usually ivory white in colour. It ooccurs most commonly among the breech wool although it may be found in any part of the fleece. It varies greatly in structure from true wool and like black fibre will not take dye.



Manner and place of opening the fleece to examine the poorest quality of wool.

Crimp or waviness varies with the breeds. The most important point in regard to crimp is that it should be regular. Regularity of crimp is an indication of soundness of fibre. The finer the wool the finer the crimp. In opening a fleece for examination the crimp should always be noted for from it an estimate can be made both as to the soundness and fineness of the fibre.

The softness of the fleece can be readily determined by pressing it with the hand. This characteristic depends largely upon the breed and grade of wool.

Condition.—The condition of a fleece is determined by freedom from foreign material, lustre, and the amount and character of the grease or yolk. The most common foreign materials are burs, chaff and dirt. Brightness depends to a large extent on freedom from dirt.

Lustre which is highly valued for the brightness it gives in light-coloured dyed goods is due to the scale covering of the wool fibre. These scales overlap one another similar to fish scales and when the wool is in a healthy condition give somewhat of a sheen to wool when light shines upon it. Lustre is more obvious in the coarser wools owing to the larger scales presenting a greater surface for reflection of light. A fleece that is in poor condition will not have this lustre. Instead of the scales overlapping one another they will stand out more or less at right angles to the wool fibre and are contributing factors to the condition which is commonly known as cotting.

Yolk is the grease or oil that is naturally secreted by the skin and which passes up through the cells forming the core of the fibre. The yolk should be evenly distributed from the base of the fibre to the top and a shortage of yolk causes a harsh feeling fleece. A plentiful supply of yolk tends, on the other hand, to keep the wool in a sound healthy condition and helps to turn rain out of the fleece.

The colour and covering of the wool over the head as is demanded by the breed of which the sheep is a representative, the region of the horn pits and back over the ears, the extension of the wool on the legs and the covering on the under surface of the body should also be observed.

DETERMINING AGE.

The age of a sheep may be estimated by the teeth. The temporary or milk teeth in the lower jaw are narrow, white and soft while the permanent teeth which replace them at yearly intervals are larger and broader, widening out toward the top and the enamel is decidedly a brighter white in colour. The permanent teeth replace the temporary teeth in pairs as the sheep grows older. The first pair or middle teeth replace the milk teeth when the sheep is 12 to 15 months old. The next pair, one on each side of the central pair appear at two years, the third pair appears at three years and the last pair at four years. Sheep that are kept in high condition for show purposes often have these changes hastened while scanty feeding or neglect may have the opposite effect. A sheep pastured on very gritty land often times will break a tooth off and before she has reached maturity. After five years the teeth begin to wear down until nothing is left but stumps or they begin to fall out.

Dentition—One lamb has eight small, narrow, temporary teeth.

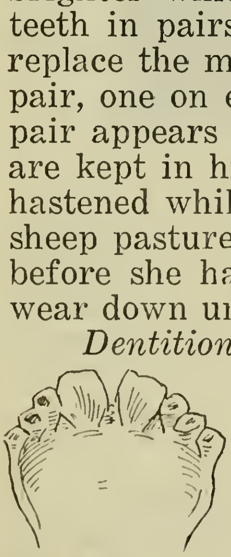


Fig. 1.

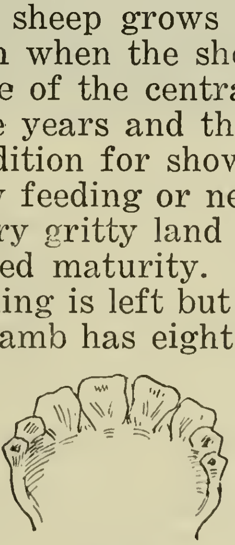


Fig. 2.

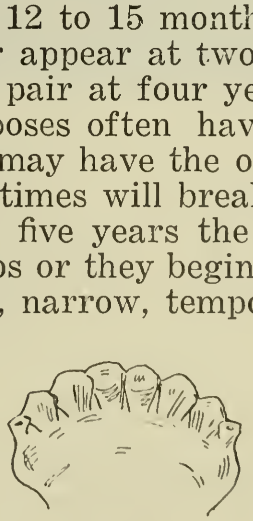


Fig. 3.

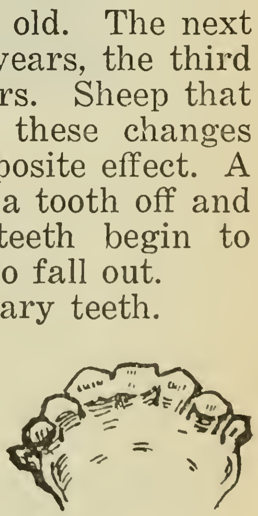


Fig. 4.

Fig. 1—Showing two central permanent incisors which appear at 12 to 15 months' old.
Fig. 2—Showing four permanent incisors which appear at two years' old.
Fig. 3—Showing six permanent incisors which appear at three years' old.
Fig. 4—Showing a full mouth at four years' old.

MUTTON SHEEP SCORE CARD.

Scale of Points.

	Possible Score
Estimated Weight—Lbs., score according to age	4
Form—Deep, broad, low set, of proportionate length, and smooth; top line and underline, straight	8
Quality—Bone, strong, but of fine texture and clean; hair, soft and thick; skin fine; all parts evenly covered with firm flesh which should be mellow to the touch, but not soft and flabby, nor yet in hard rolls or ridges; light in offal	8
Style—Spirited and attractive, indicating vigor and breeding	4
Muzzle—Fine, lips thin, but large mouth and nostrils	1
Eyes—Prominent and bright	1
Face—Short, clean cut appearance	2
Forehead and Poll—Wide between the eyes and also between the ears	2
Ears—Medium size, fine texture, erect	1
Neck—Thick and short, tapering nicely from shoulders to head with full neck vein and broad and full on top in front of shoulders, carrying head erect; throat, free from folds; in ram, crest well developed	4
Shoulders—Fitting smoothly into ribs, evenly covered with flesh, moderately broad but compact on top	4
Legs—Straight and short; set well apart; strong, but with clean, smooth shank; pasterns, strong and upright; arm, broad and well muscled	2
Chest—Deep and wide; breast full; brisket prominent and blunt; space back of shoulders well filled leaving no depression; heart girth large	9
Back and Ribs—Back broad and straight, well fleshed and smooth; ribs deep, well arched, thickly fleshed	9
Loin—Deeply fleshed, coming out full to hips and carrying width evenly from hips forward	6
Flank—Full and even with underline	2
Hips—Wide, level, smooth	3
Rump—Long, wide, level, well filled from hips to tail head, smooth	4
Thighs—Full, deep and wide, both on inside and outside	4
Twist—Full and deep, nearly as low as flank	4
Legs—Straight and short, set well apart, strong, but with clean, smooth shank; pasterns, strong and upright	2
Wool:—	
Quantity—Long, dense, even	5
Quality—Fine, pure, crimp, close, regular, even	5
Condition—Bright, sound, clean, lustrous, good secretion of yolk	4
Skin—A healthy, light cherry colour and free from dark spots	2
Total	100

SWINE.

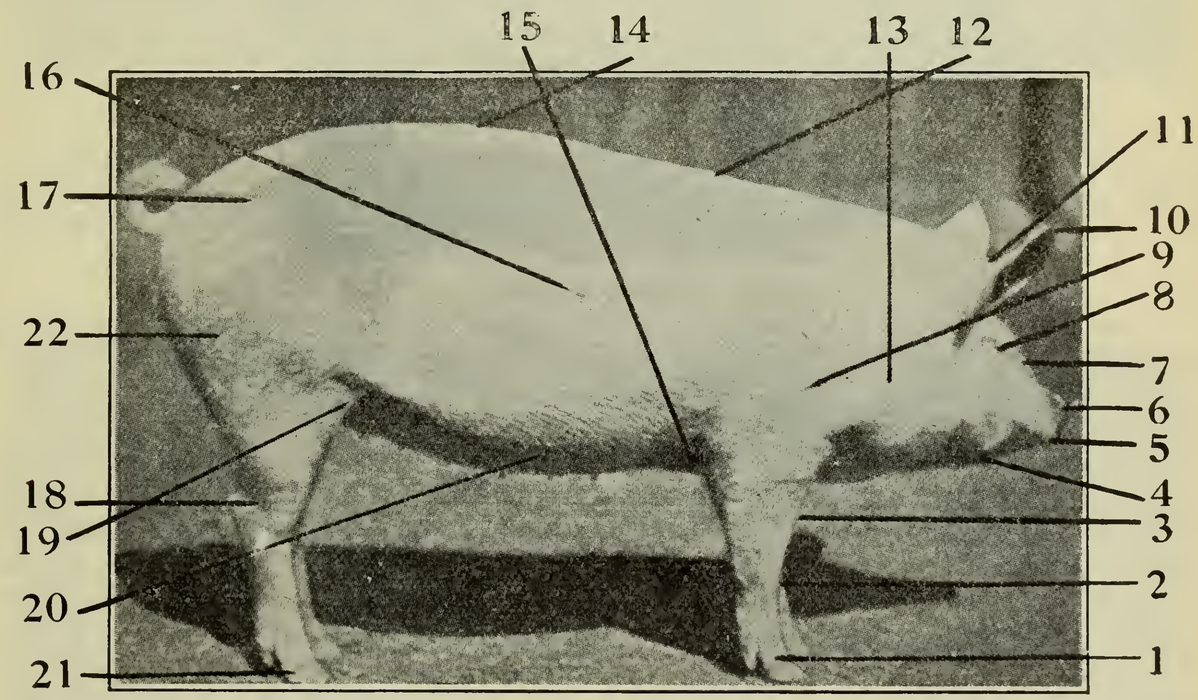
Bacon and Lard Types.—All hogs may be divided roughly into two classes known respectively as the bacon type and lard type. It is mainly with the bacon type hog that the Ontario farmer is concerned although some lard type hogs are bred in southwestern Ontario. The bacon type is lean and muscular in appearance and is a producer of a comparatively large proportion of lean meat to fat whereas the typical lard hog when in market condition is shorter bodied, thicker made and heavier in his hams and shoulders. The lard type hog of to-day, however, is not so low set and thick and wasteful as his ancestry of a few years ago.

The breeds of hogs included in the respective types are shown in the following classification:

Bacon Type—Large Yorkshire, Tamworth, Berkshire.

Lard Type—Poland China, Duroc Jersey, Chester White, Hampshire, spotted Poland China, and Large Black.

While the Large Black has been placed in the lard type class there are strains of this breed, which when properly fed, will produce a certain percentage of hogs that will hang up Wiltshire sides.

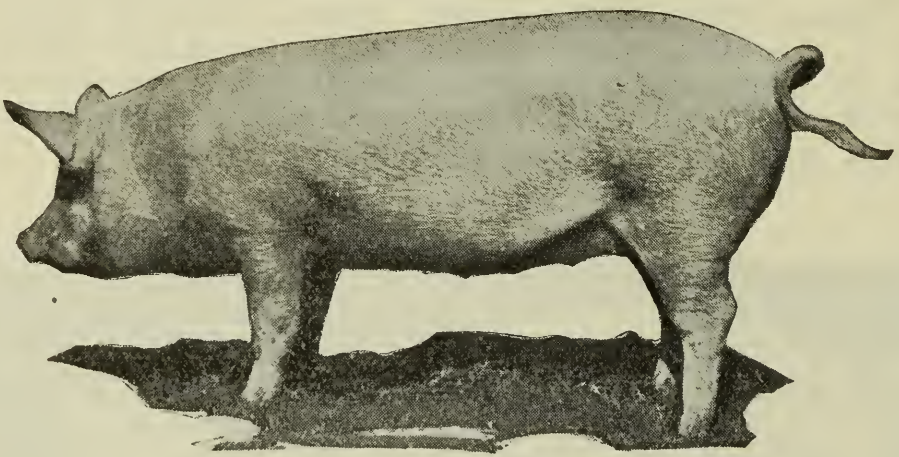


Points of a Pig.

1. Pastern
2. Knee
3. Foreleg
4. Jowl
5. Mouth
6. Snout
7. Face
8. Eye
9. Shoulder
10. Ear.
11. Poll
12. Back
13. Neck
14. Loin
15. Fore Flank
16. Side
17. Rump
18. Hock
19. Rear Flank
20. Belly
21. Foot
22. Ham

Method of Judging Swine.

In judging swine one is well advised to stand back some distance from the animal so that he is afforded an opportunity of getting a proper view of the hog. A hog should be made to move around while under inspection. When viewing him from the side an idea of his general balance of body, his trimness, straightness of lines, depth of body, strength of constitution, arch of top, depth of loin, quality of bone, firmness of fleshing, the manner in which he stands on his feet including strength of pastern, and quality of hair may be ascertained. A view from the front will show his clean cut appearance about the head, setting of ear, width of poll, width between the eyes, blending of neck into shoulder, and shoulder into body, and, to some extent, the eveness of spread throughout. An accurate idea of the width of chest floor also may be had from this viewpoint. The shape and development of ham and the filling between the hams may be discovered when standing in the rear of the hog. Moreover, one's impression as to the smoothness of top gained from the front view may be confirmed when viewing him from the rear. This latter position of inspection affords one a splendid opportunity to decide the amount of fleshing and the quality of fleshing which the hog is carrying. More information as to the manner in which the hog stands on his hind legs may also be had when standing behind him.

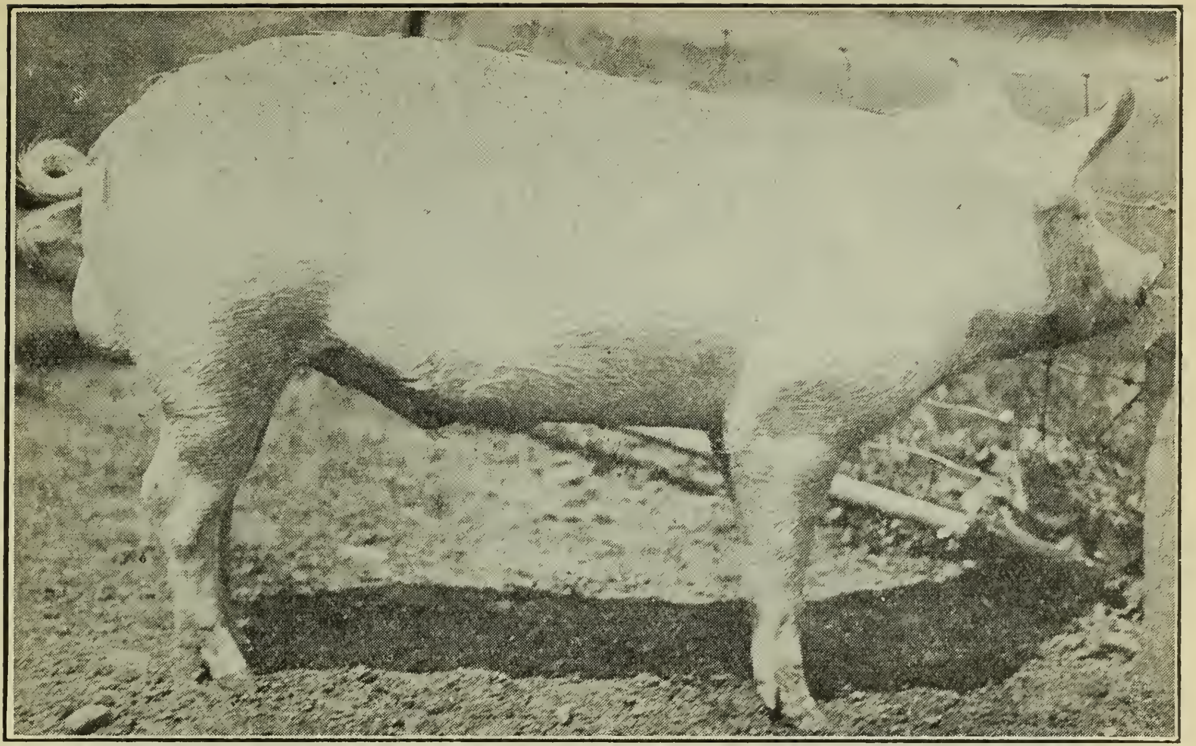


A SELECT HOG.

Note the length of side, smoothness throughout, trimness of jowl and underline, and uniformity of depth.

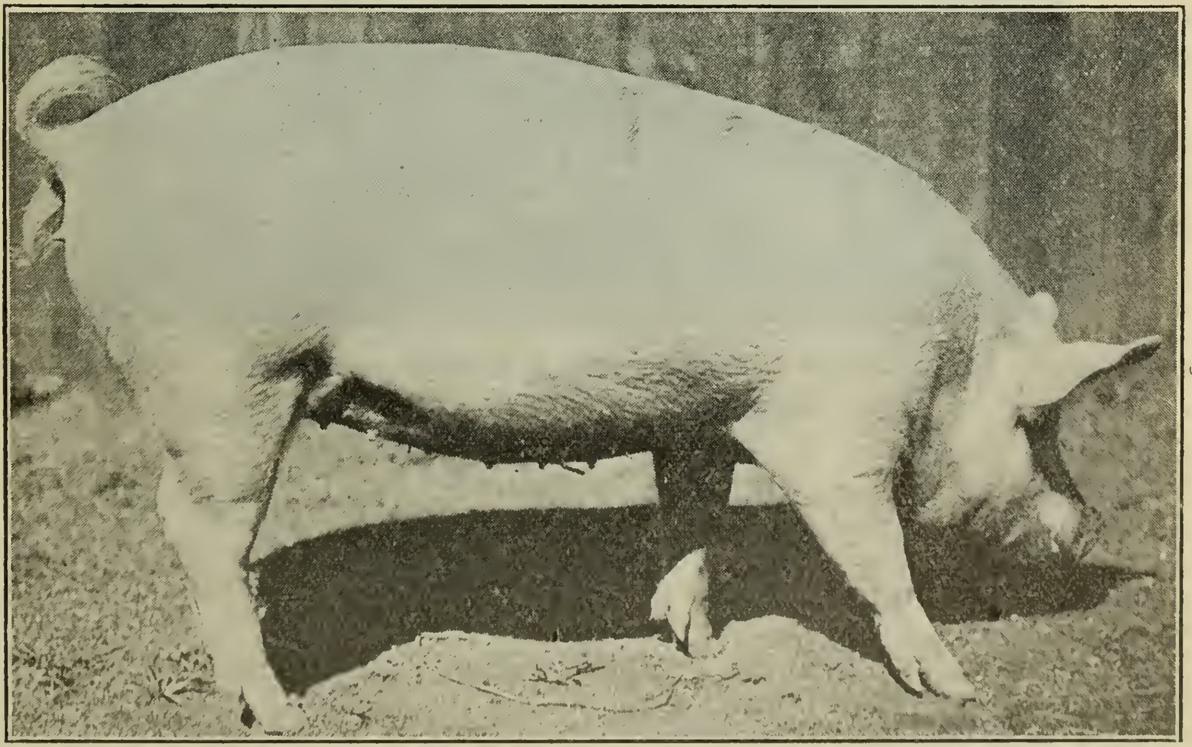
BACON TYPE—

As to individuality, a bacon type hog should carry a balance of body. He should have length, trimness, smoothness and quality, and should show a reasonable amount of arch of back. He should have a clean-cut head with good width between the eyes and at the poll. The jowl should be firm and trim. His neck should be of medium length and muscular. The shoulder should be neatly set into the body with the shoulder blades well filled between with muscle. A bacon hog should have a sufficient depth of body along with width of chest floor to ensure a strong constitution. Without that strength we cannot expect best feeding results. His side should be of good length and flat, with the rib coming out from the backbone sufficiently far to give him width enough to allow for internal organs to develop and function properly. The loin should be deep and strong, and as wide as the rest of the back, and his rump should gradually slope to the tail head, being slightly rounded from side to side over the top with no indication of coarseness or flabbiness in that region. He should be just as deep and full at his rear flank as at his fore flank, which, with a trim belly line, should give him a full and practically straight underline. His ham should be smooth and firm, with the flesh carried well around the bone and tapering toward the hock. Great flabby, bulging hams are not wanted on a bacon hog. If a straight edge were to be laid along his side it should touch at every point. As to quality and quantity of bone the bacon hog should possess clean, strong bone, with no indication of coarseness about his joints, and he should



EIGHT MONTHS' OLD BOAR.

This young hog is the type from which to produce bacon hogs. He is out of an even litter of 16 pigs. Note length, smoothness, balance and general conformation. Owned by Ontario Agricultural College.



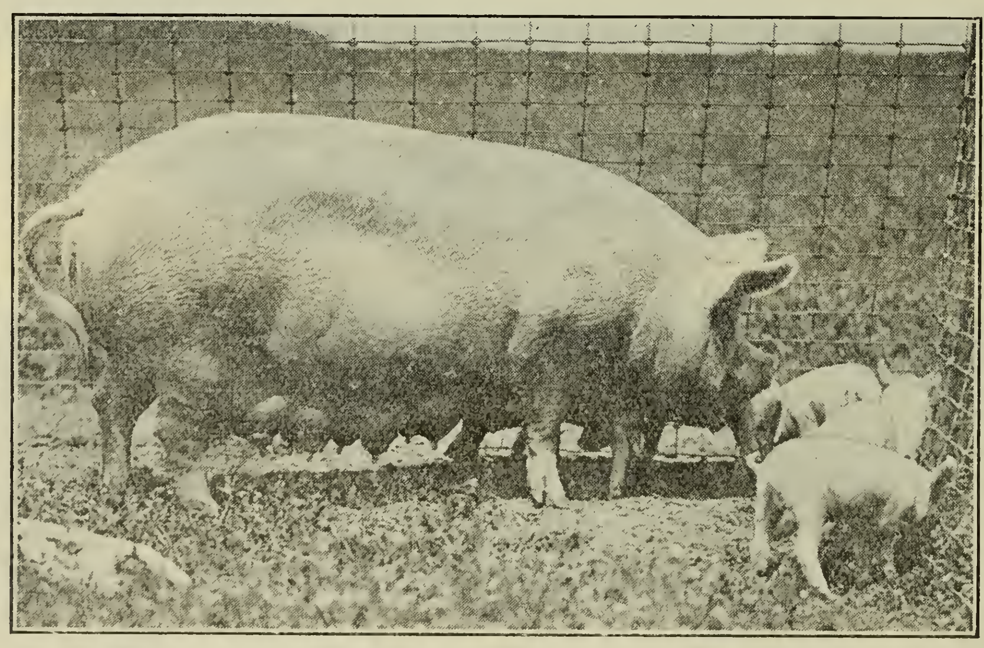
A GOOD TYPE OF YOUNG BREEDING GILT.

This eight months' old gilt shows the proper proportions to make an ideal brood sow for the production of bacon. Owned by Ontario Agricultural College.

stand straight and squarely on his feet. Any tendency toward weakness of pasterns is very undesirable. His hair should be of reasonable quantity and of good quality. Coarse, curly hair on a bacon hog is not indicative of quality. Extremes are to be avoided. The razor-backed hog is not a bacon hig. Neither is the narrow-chested, shallow-bodied, extreme hog an economical pork producer.

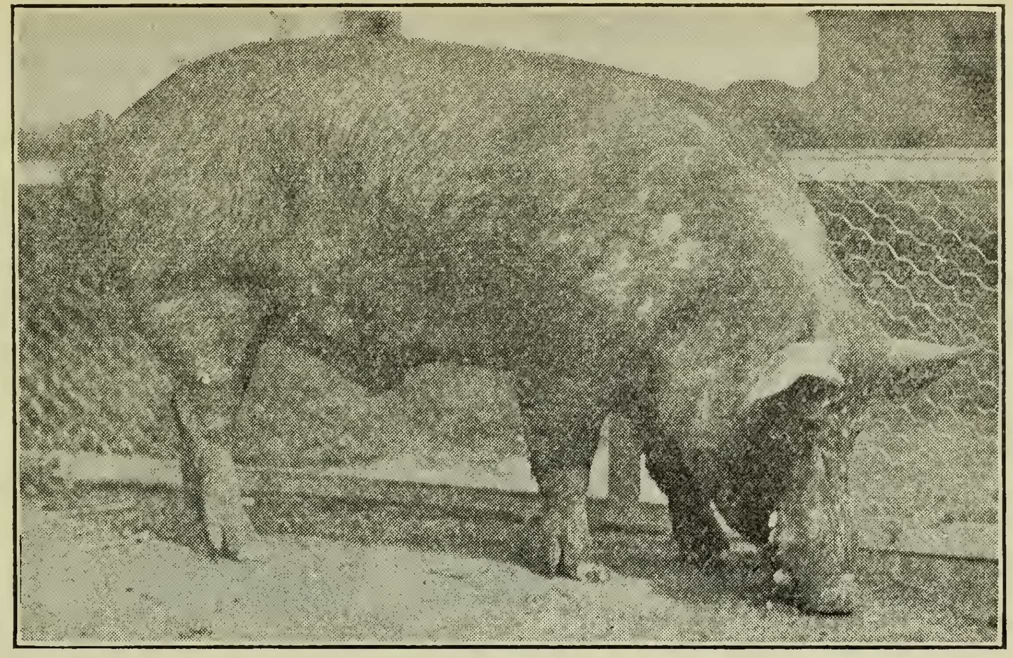
In a finished class he should be *finished* but not overfat and should weigh at the market 170 lbs. to 220 lbs. or 180 lbs. to 230 lbs. at the farm. Length without smoothness and finish does not make a desirable hog neither does smoothness and finish without length. The belly should be trim and neat and when on the walk there should be a general indication of firmness. Firmness denotes muscular tendency and muscular tendency denotes lean meat rather than fat.

The *Large Yorkshire* or Large White is as the name would imply one of the largest breeds of swine. In colour, a clear white is desirable. Black hairs or black patches of hairs are a disqualification but dark or bluish spots in the skin while objectionable do not disqualify provided the hair is all white. Breeders try to avoid dark blotches in the skin.

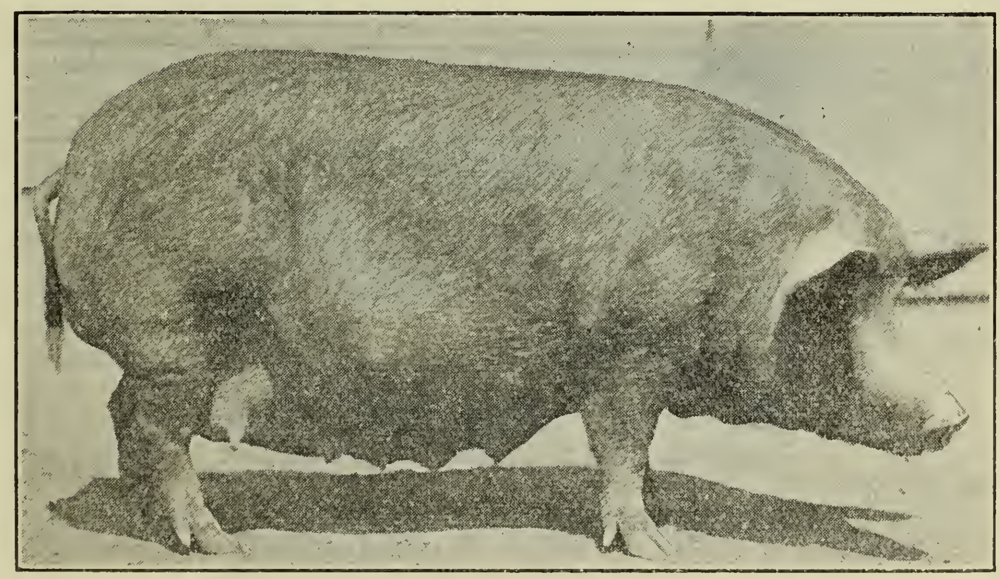


An old Yorkshire sow with eight pigs in a clover paddock at the O.A.C.

The Large Yorkshire is distinctly a bacon hog. The best specimens of the breed show a head of medium length with the face slightly dished and the nose practically straight. Considerable width between the eyes is characteristic of the breed. The ears should be of medium size, firmly attached to the head, and carried erect. The neck is of medium length and the jowl while of fair width is neat and trim with no indication of flabbiness. The shoulders are compact and only medium in width and the sides should be long and fairly deep with a trim underline, the whole side being so smooth that a straight edge laid along it would touch practically all the way from shoulder to ham. The ham should taper gradually from the twist to the hock and show no wrinkles. In bone, the Large Yorkshire should be strong and the body should be set on legs of fair length not too long nor yet too short. All pigs, particularly breeding stock, should show plenty of strength of pasterns.



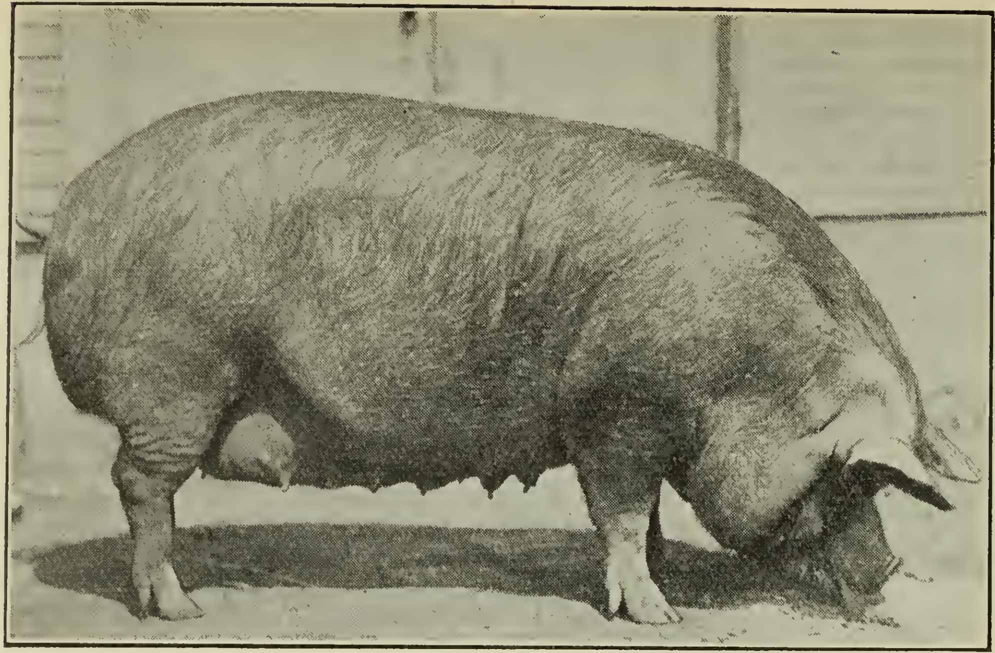
Maplehurst Defiance—15286. Tamworth herd sire, O.A.C. Note type and size for age.



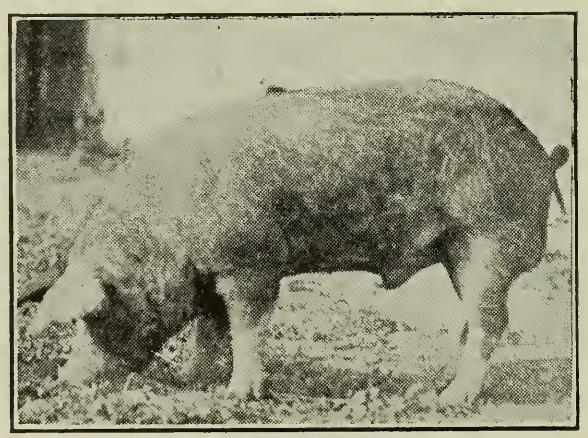
TAMWORTH BROOD SOW.

She has been a consistent producer in the O.A.C. herd. Long, deep, and smooth, she is the kind that pays.

The *Tamworth* compares favourably with the Large Yorkshire in size. The colour is described as a golden red, with a flesh coloured skin free from black. The shade of red, however, varies a good deal from a very light to quite a dark shade. It is noted that the colour generally grows darker with age. The face has a slight dish and the snout is rather long and straight. Narrowness between the eyes while often times noticed in this breed is not really desirable. The ears are fairly large, not as thick as the Yorkshire's, firmly attached to the head and carried upright or inclined slightly forward. The neck is fairly long and the jowl shows the lightness and trimness of the bacon breeds. The shoulder is extremely smooth and medium in width; the side long and of good depth and the ham very trim and neat. The bone is fairly heavy and of good quality.



A Berkshire Sow at the O.A.C.
Note the length, strength and quality.



Berkshire Boar, O.A.C.
Sandford Puddington—65314. 9 months' old, O.A.C. sire.
Grand Champion Royal Winter Fair, 1926.

The Berkshire as it is bred in Canada to-day conforms a great deal closer to bacon type than did the old type Berkshires. The colour is black with white markings on the face, on the feet, and tip of tail. White blotches on the body are an objection. The face of the Berkshire is slightly dished, the snout of medium length and the jowl full and fairly heavy. The Berkshire has a strong, broad back with good thickness over the rump and through the ham. The Berkshire usually has a heavy ham which is generally quite trim. Depth of body is also characteristic of the breed and while the bone is sometimes rather light, the best individuals stand well on their legs. Berkshires, as a breed, show a considerable amount of quality.

Judging Breeding Stock.

In judging breeding stock all the characteristics which have been mentioned under the heading of bacon type as applied to body conformation should be taken into consideration. The type of breeding stock is one of the main determining factors in the type of the commercial stock finding its way to our markets. Over and above these characteristics sex characteristics should be given strict attention. In the case of the brood sow or breeding gilt along with a feminine appearance there should be an indication of satisfactory mammary development. In both sexes there should be an indication of satisfactory mammary development. In both sexes there should be an indication of strength of constitution while a boar should have sufficient depth of body to provide this requisite, it is well for a sow to have a still greater depth of body. The deep, flat sided sow with a firm underline along with the other desirable characteristics already mentioned mated with a boar of reasonable depth of body and of good type otherwise, should produce a desirable type of hog.

SCORE CARD FOR SWINE OF BACON TYPE.

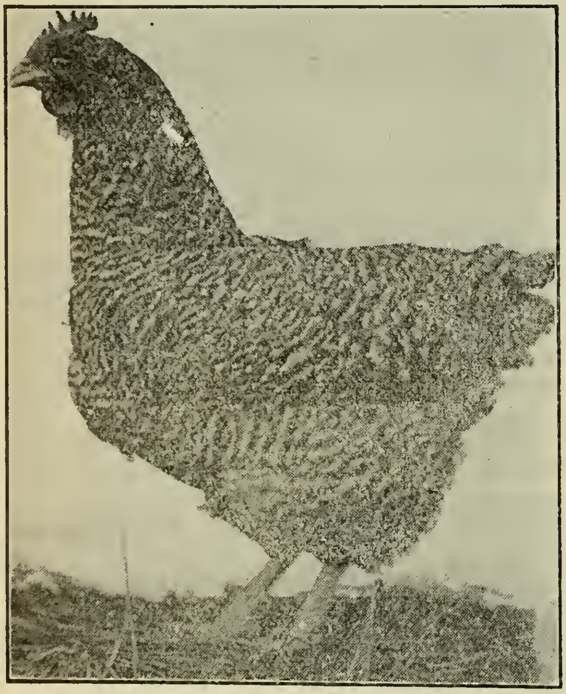
SCALE OF POINTS.

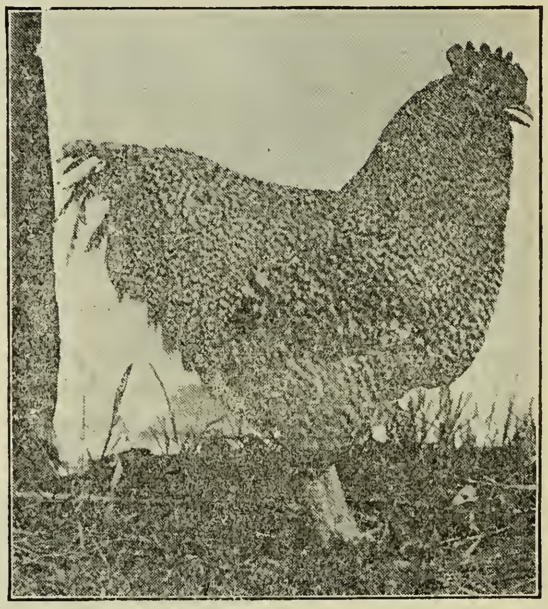
	Possible Score
Size—Well developed for age	5
Form—Long, smooth, all parts proportionately developed so as to give the impression of a well-balanced, strongly-built animal. Top line, strong, underline, straight, belly trim and neat	10
Quality—Hair, fine; skin, smooth, showing no tendency to wrinkle; bone, clean and strong, but not coarse; flesh, firm and smooth, with no flabbiness at jowl, fore-flank, belly or ham	10
Condition—Well covered with firm flesh, especially along back and loin, but not heavily loaded with fat	6
Style—Active and sprightly, walking without a swaying movement and standing well up on toes. Breeding animals should show strong character	4
Snout—Medium length and moderately fine	1
Face—Broad between eyes; poll, broad and full	1
Eyes—Good size, full and bright	1
Jowl—Fair width and muscular, but very neat, showing no flabbiness	2
Ears—Moderately thin, and fringed with fine hair	1
Neck—Medium length and muscular, but possessing no tendency to arch on top	2
Shoulders—Smooth, somewhat rounded from side to side over top, and very compact; no wider than back, and not running back on side so as to shorten distance between shoulder and ham	6
Breast—Good width and full	3
Fore Legs—Set well apart, medium length and straight; pasterns upright; bone, clean and strong; feet medium size and strongly formed	4
Back—Medium width, rising slightly above the straight line, and forming a very slight arch from neck to root of tail	6
Loin—Width as rest of back, strong and full, but not unduly arched	5
Ribs—Good length and moderately arched	4
Side—Fairly deep; long, smooth and straight between shoulder and ham; a straight edge laid over shoulder point and ham should touch the side throughout	8
Heart-girth—Full, but not flabby at fore-flanks, filled out even with side of shoulder; there should be no tucked-up appearance back of fore-legs, nor droop back of shoulder top	5
Flank—Full and low	2
Rump—Same width as back; long and slightly rounded from a point above hips to tail and somewhat rounded from side to side over top	4
Ham—Full, without flabbiness, thigh, tapering towards hock without wrinkles or folds ,and carrying flesh well down towards hock	6
Hind Legs—Medium length, hocks set well apart but not bowed outward; bone, clean and strong; pasterns, upright; feet, medium size and strongly formed	4
Total	100

JUDGING POULTRY.

Judge birds for Vigour, Breed Type, Production and Feather Marking. Marking.

1. *Vigour*—Vigour is of first importance in judging breeding stock. Look for—A well developed body properly balanced. An eye which is bright, full and prominent. A head of medium length, (discard the long crow head or the extremely fine head.) Moderately heavy bone in shanks and the body balanced on the legs.





Typical Specimens of Barred Plymouth Rocks—Production Strain.

Fig. 1. H69 laid 249 eggs in her pullet year.

Fig. 2. L48-L49 is a son of H69.

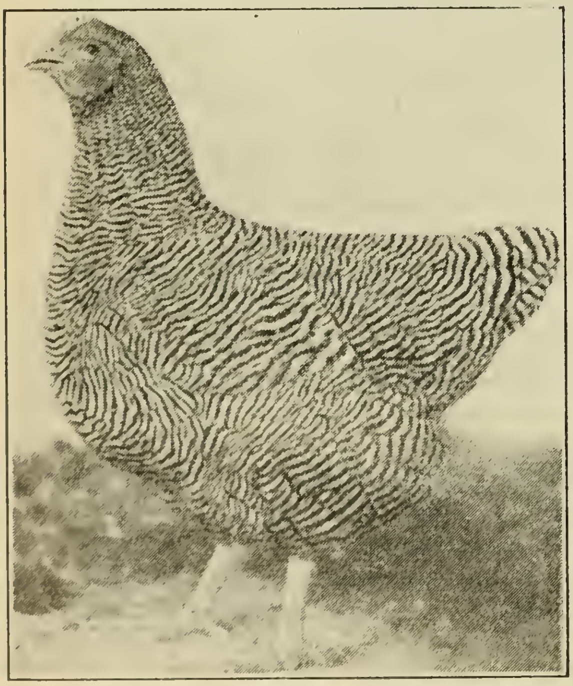


Fig. 3.

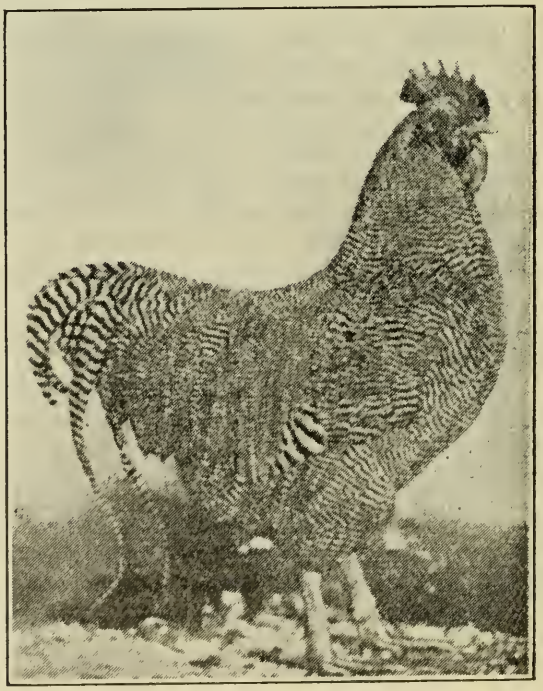


Fig. 4.

Typical Specimens of Barred Plymouth Rocks—Exhibition Strain.
The ideal is to combine the good qualities of both strains.

2. *Breed Type*—Look for breed type, use the standards for type, colour and general breed characteristics as presented in the *American Standard of Perfection.* (This is the standard for all breeds of poultry and is sold by the Students' Co-operative Supply Co., O.A.C., Guelph.)

3. *Body Type*—Handle all birds to determine body type as well as feather type or type as seen with the eye.

4. *Disqualifications*—Do not overlook disqualifying defects in birds. These are all listed in the "Standard," and include side sprigs on the comb, stubs and feathers on shanks and feet, birds under standard weight, and many others.

5. *Feather Marking*—Do not neglect to give some consideration to plumage colour. It is a distinct variety characteristic. Lack of proper colour makes a mongrel.

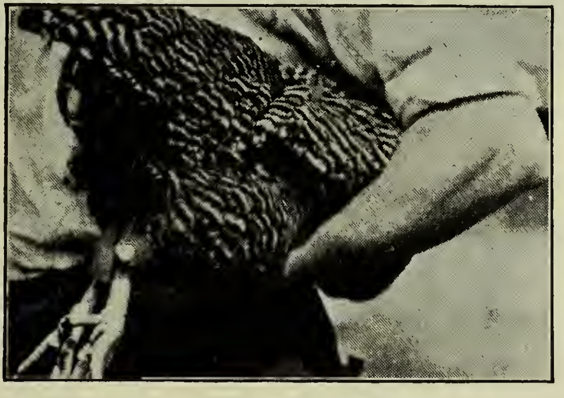


Fig. 5. Method of holding bird.

HOW TO HOLD AND HANDLE BIRDS.

The amateur poultryman often experiences considerable inconvenience in handling birds and just as often causes the bird much worry while handling. Fig. No. 5 shows the proper way to hold a bird. The hen, when held on the arm in this way, with the keel bone resting on the arm, the first finger between the hocks and the thumb and the second finger used to grasp the upper shank, will rest quietly and give one a chance to examine the various points to be considered.

JUDGING FOWL FOR PRODUCTION.

In judging for Production as well as for Exhibition quality, the foregoing factors *must* receive due consideration.

To be of most value a hen should not only lay well, but must look good.

Heavy egg production over a protracted period will detract somewhat from a bird's appearance. A hen and her offspring are, however, far more valuable if the hen is a good representative of the variety of the breed to which she belongs. This need not injure her ability as a layer.

In judging for Production proper, the following factors are of importance.

I.—*VIGOUR*—

Absolutely necessary to ensure persistance in production for one year or over a period of years.

Indications—A well developed body, well balanced; strong skeletal frame and shanks; eyes that are bright, full and prominent; fearless in

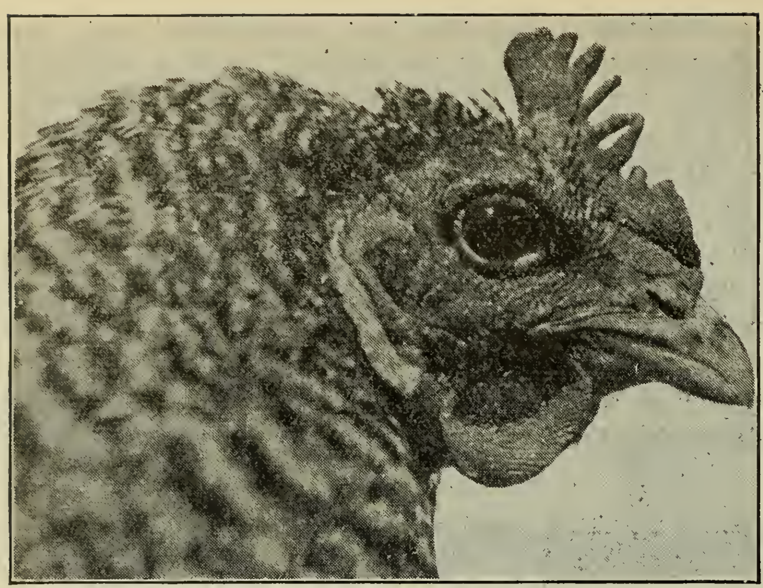


Fig. 6. Side view of good head.

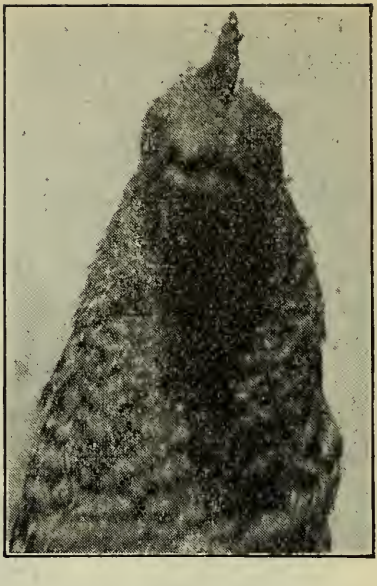


Fig. 7. Front view of good head.

the males; a head that is medium in length, broad but clear cut; a good spring of rib; straight legs, set well apart; plenty of red on shanks of males; straight toes and a sprightly walk; a rich yellow colour of shanks and beaks, of male birds and females not layng, of the yellow skinned breeds.

Head Types—The head tells an interesting story: The long or crow-headed type is an indication of low producing ability and often lack of constitution. The short beefy head indicates a sluggish type and is often correlated with a predisposed tendency to fatten and a small egg production.

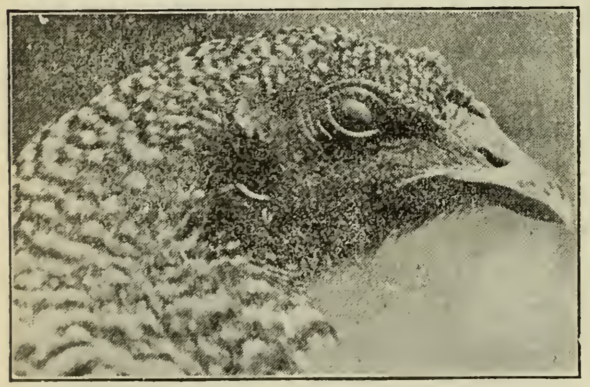


Fig. 8. Side view of poor head. (Crow head.)

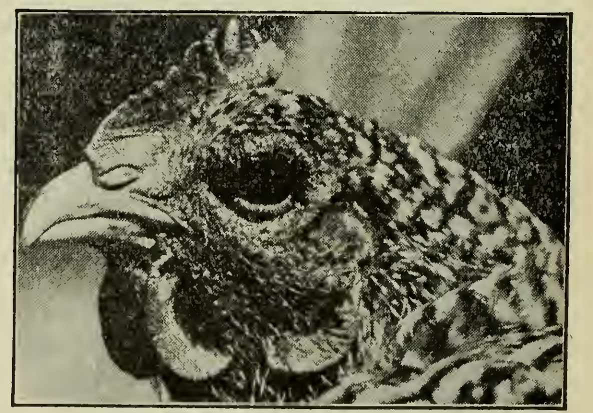


Fig. 9. Side view of poor head. (Fat head.)

The illustrations show several interesting features in heads. Figs. Nos. 6 and 7 show heads with abundance of character. Note the well turned beak, fine texture of skin about the face, the bright prominent eye well back in an eye socket showing white membrane in front, the absence of wrinkles or beefiness over the eye and about the face. The comb is waxy and bright. These heads have vigour, action, and "pep" sticking out all over them.

Compare these heads with Nos. 8 and 9. Here we find the long pointed beak, dull comb, or the type with wrinkles of fat over the eye and the coarse skin about the face. The dull, sluggish eye set in a close

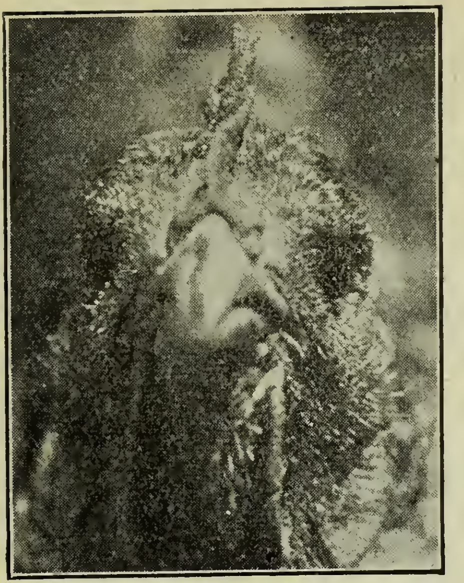


Fig. 10. Broody head.

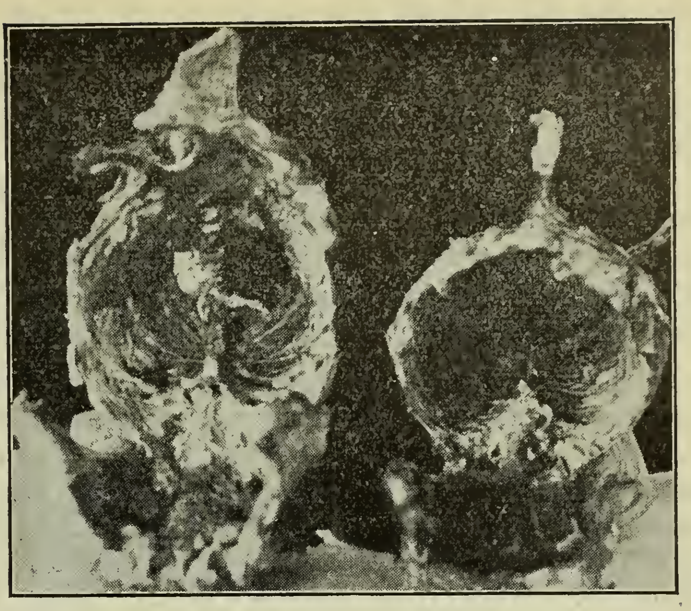


Fig. 11. Rear view of skeletons.

round eye socket does not show the life and character the other heads exhibit so plainly. No. 10 is a typical broody head. By passing the finger carefully along over the head from the rear of the beak and just over the eye to the side of the comb a distinct bump can be felt. This in the craniology of the hen is her broody bump and indicates a predisposition to exercise her maternal franchise instead of staying steadily in the world of production. Note the absence of this prominence in the heads of heavy layers. There is a danger of going to extremes in head types, and the hen with the extremely fine or delicate head is apt to lack vigour and may not stand up against heavy production. This type, however, is rather rare, and the fault is not as common as the heavy, broody head.

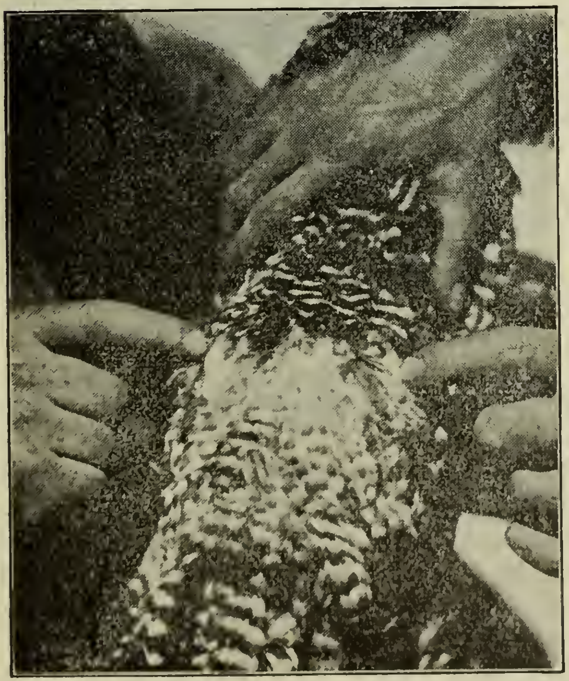


Fig. 12. Broad flat back carrying its width to the tail.

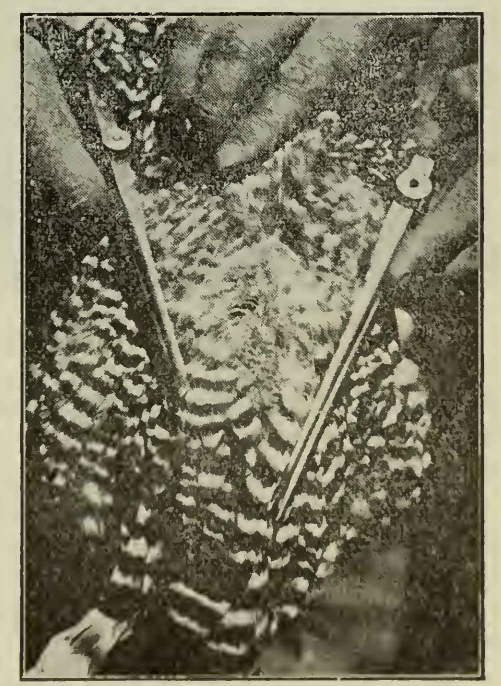


Fig. 13. Rounded back forming a wedge with the tail. Poor type.

II.—*BODY TYPE*—

Indications—A rectangular shaped body, deep from shoulders to breast, and wide over the back from the heart region to the end of the pelvic arch.

A long straight breast bone or keel starting well forward and leading far back; thus supporting the abdomen.

Good width, especially when laying, between the pelvic bones which are fine and straight, and between the pelvic bones and the keel.

The body carried in a horizontal position by properly balanced legs.

The shape of the keel bone is important. In high producers the keel frequently has a decided hook or turn down at the end. This is a good feature, and while not always found is generally a sign of early and persistent production in pullet year. This conformation of keel bone is what goes to make capacity in the egg sack. The undesirable type of keel is one which has a decided upward direction towards the vent, and such birds are often described as being canoe keeled.

In order to determine the capacity of the egg sack the hand can be placed at the rear of the bird as shown in Fig. 14. The lower finger can readily find the position of the end of the keel and the first finger the position of the pelvic bones. These pelvics are two thin bones projecting out one on each side of the vent and just above it. The measure of the distance from these bones to the end of the keel is called the capacity and is spoken of in terms of the number of fingers one is able to insert. Fig. 15 shows a poor producer with a canoe keel and only two fingers capacity. Compare this with the hen shown in Fig. 14 having more than four fingers capacity and note the relation of this capacity to the production of the birds.

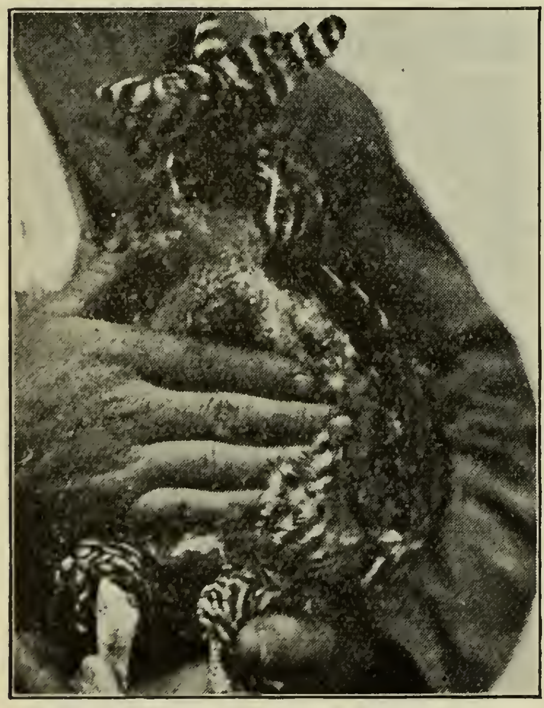


Fig. 14. Good capacity—292 eggs.

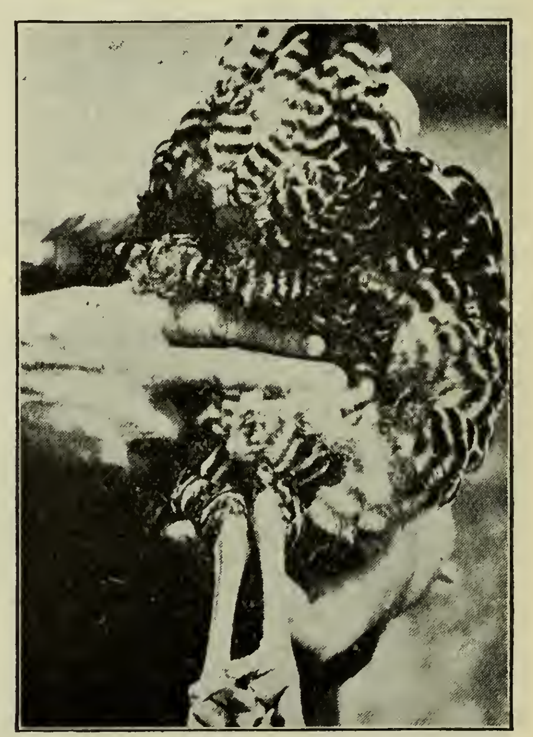


Fig. 15. Poor capacity—84 eggs.

The capacity of a hen is not always the same. If the ovary is dormant and no eggs are being manufactured the capacity will be rather small. However, as soon as ovulation commences the distance between the pelvic bones and the keel begins to increase and in full ovulation, or at a hen's highest production, the capacity of the bird will be the greatest.

Any one who has dressed hens will have noticed the large accumulation of fat in the abdomen of some birds. This accumulation can be determined while the hen is living by handling the flesh in the egg sack. The fat if present will be hard and firm. This is a sign that ovulation has ceased and that the hen is now using her feed supply to lay up fat instead of producing eggs. If a hen has accumulated a quantity of hard fat in the abdomen it is almost a sure criterion that the hen's laying days are about spent, and it is time that her day's work in the flock was done and she should be sent to market.

III. *QUALITY—*

Indications—Fine textured skin in the face which is practically free of feathers. A clean cut head. A waxy condition of the comb and wattles. Fine textured skin throughout the body. Medium sized, closely set and smooth scales on the shanks. A soft pliable condition of the pelvic region.

IV.—*PIGMENTATION—*

A progressive disappearance of the yellow colouring material with the advance of production, in yellow skinned breeds of fowl.

Indications—Vent open and moist with colour bleached out at from commencement up to about one week of production. Thus a bird with a bleached vent is laying: one with a yellow vent is not laying.

Eye Ring—Pigment gone after ten days to two weeks production.

Ear Lobes—In Leghorns fade slightly slower than do the eye rings.

Beak—The colour here fades from the base out to the tip and more rapidly in the lower beak than in the upper one. A bleached beak indicates four to six weeks of continued production.

Shanks—The colour here fades progressively from the front and upper part of the shanks, downwards and back. It leaves the heel or back of the shank and the coarse toe joint scales last. Completely faded shanks indicate consistent heavy production for a period of from about four to six months, depending upon the kind of feed consumed. Large sized birds and birds fed considerable corn (yellow) and green grass do not fade as rapidly as do smaller birds receiving little or no green feed.

Birds that are not well may be quite faded in all parts without laying many or any eggs.

Plumage—Persistent laying over a period of six months or more leaves the plumage rather dry and harsh to the touch. It will also be somewhat ragged and frayed in appearance. A heavy laying hen is moderately tight feathered, as a rule, carrying the feathers close against the body.

When laying stops, the yellow colour reappears in the different sections noted, in the same order as it disappears.

V.—*BROODINESS—*

Indications—By the moulting out of primary wing feathers at more or less regular intervals throughout the summer months. During each broody period a primary feather is moulted out of each wing and new ones are grown in.

The eye lids instead of having a regular round or oval shape, show an angular condition at the front and upper part of the eyes. This is surmounted by a projecting and angular eye brow.

VI. *MOULTING—*

Indications—The heavy layer usually moults late in the season. When moulting, hens rarely continue to lay. The progress of the moult indicates the length of time the hen has been moulting, hence not laying.

It takes about six weeks to completely renew the primary or main wing feathers next to the axial feathers. It takes about two weeks more to completely renew each succeeding primary.

VII. *DISPOSITION—*

Indications—The high producing hen is of an active, nervous disposition. She is friendly and will quietly submit to handling, and will frequently sing while being handled or observed. The low producer is usually wild, hard to catch and handle and inclined to squawk.

To be successful in judging for Production, a comprehensive idea of the whole bird must be formed. No undue prominence should be given to any particular sections.

A symmetrical bird, well developed in all sections is the one most to be desired.

JUDGING GRAINS, GRASS AND CLOVER SEEDS, POTATOES AND ROOTS.

The following brief notes have been prepared primarily for the use of young farmers in connection with their local short courses and judging competitions, but will also be useful to men preparing themselves for judging at fairs and exhibitions.

Score cards have been included, but it should be understood that these are intended only for the use of students in training. They are for the special purpose of calling attention to the main points which should be considered in judging and to indicate approximately the relative value of these points. Score cards are seldom or never used in actual judging in the show room or show ring.

JUDGING BARLEY FOR SEED.

The main points in judging barley may be discussed as follows:

1. *Brightness of Colour*—This point is always emphasized in barley since it is the chief indication of freshness and ability to germinate quickly and evenly. Barley discolours very readily from exposure to weather or with age.

2. *Size and Uniformity*—The kernels should be of uniform good size for the variety. This point should be carefully watched because the seed (especially of six-rowed varieties) naturally lacks uniformity in size, and for seed purposes the smaller seeds should be graded out since they have not the same ability to give the resulting young plants a vigorous start in life.

3. *Plumpness*—Plump seeds are generally well matured and more capable of producing strong young plants than are the more shrunken ones.

4. *Soundness*—Barley is frequently more or less broken in the threshing process. The seeds break crosswise so that one-half is not capable of germinating at all, since it has no germ, and the other half containing the germ has not a full supply of plant food material for the resulting young plant when it starts to grow; hence there should be no broken seeds left in the seed barley.

5. *Weight per Measured Bushel*—This is an indication of quality and is more important in judging barley than in judging cats since there is less variation in the thickness of hull on barley.

6. *Freedom from Foreign Seeds*—This means freedom from weed seeds or seeds of other kinds of grain and cannot be judged at a glance. At least a portion of each lot of seed should be thoroughly examined so that the judge may know exactly how many and what kinds of foreign seeds are in it.

7. *Purity of Variety*—This means that the sample should be free from kernels of other varieties of barley and is important, though not so important as freedom from foreign seeds. The presence of mixture will be indicated chiefly by difference in shape, colour and size of kernel.

SCORE CARD.	Points
Size and uniformity	20
Plumpness	12
Soundness	10
Freedom from foreign seeds	18
Brightness of colour	15
Weigh per bushel	15
Purity of variety	10
Total	100

JUDGING OATS FOR SEED.

The main ponts in judging oats may be discussed as follows:—

1. *Germinating Power*—In oats this will be indicated chiefly by the absence of any mouldy smell, dullness of colour, or a greenness of colour indicating immaturity.

2. *Size and Plumpness*—The kernels should be of uniform good size for the variety and well filled out indicating capacity to produce vigorous young plants. There should also be an absence of any double oats or small pin oats.

3. *Thinness of Hull*—In judging oats, quality can usually be determined better by thinness of hull than by weight per bushel. Indeed weight per bushel is of comparatively little value in judging oats since it is not definitely correlated with thinness of hull. Sometimes samples with very thick hull are heavy in weight per bushel and sometimes the opposite is true. Often very plump appearing oats have a very thick hull and sometimes the opposite is true. The judge, therefore, should always take time to select at random not less than a dozen kernels from each entry and to remove the hulls from these to determine as nearly as possible the proportion of hull to kernel and the thickness or toughness of the hull. Thick, tough-hulled oats, even though they may have large kernels, are hard for animals to masticate and hence have a low feeding value. Varieties having this characteristic should not be used for seed.

4. *Freedom from Foreign Seeds*—This means freedom from weed seeds or seeds of other kinds of grain and cannot be judged at a glance. At least a portion of each lot of seed should be thoroughly examined so that the judge may know exactly how many and what kinds of foreign seeds are in it.

5. *Purity of Variety*—This means that the sample should be free from kernels of other varieties of oats. It is important, though not so important as freedom from foreign seeds. The presence of mixture will be indicated chiefly by difference in shape, colour and size of kernel.

SCORE CARD.

	Points
Germinating power	20
Size and plumpness	20
Freedom from foreign seeds	20
Thinness of hull	25
Purity of variety	15
Total	100

JUDGING WHEAT FOR SEED.

The main points in judging wheat may be discussed as follows:—

1. *Germinating Power*—In the threshing process wheat grains lose their chaff or hull, hence the germs are more exposed to adverse conditions and are more likely to be injured than they would be in barley or oats which retain the hull. For this reason the germ end of the grain should be carefully examined to see that there is no mouldiness, discolouration or indication of previous sprouting.

2. *Size and Plumpness*—The grain should be of uniform good size for the variety and nicely filled out indicating capacity to produce vigorous young plants.

3. *Freedom from Foreign Seeds*—This means freedom from weed seeds or seeds of other kinds of grain and cannot be judged at a glance.

At least a portion of each lot of seed should be thoroughly examined so that the judge may know exactly how many and what kinds of foreign seeds are in it.

4. *Weight per Measured Bushel*—In wheat this is an indication of soundness and high quality. At most large shows the weight per bushel of all samples is determined by use of an instrument. This is usually done in advance of the judging and the weight of each sample placed on the entry card, or on a separate tag, so as to save time for the judge.

5. *Purity of Variety*—This means that the sample should be free from kernels of other varieties of wheat. It is impoortant though not so important as freedom from foreign seeds. The presence of mixture will be indicated chiefly by difference in shape, colour and size of kernel.

6. *Hardness*—Hardness indicates quality and may be determined partly by biting or cutting some of the seeds, or by the appearance. Hard kernels appear a little darker in colour and are more flinty or translucent in appearance.

In judging wheat there should also be a careful look-out for the presence of smut balls. Smut balls are a little smaller and rounder than wheat kernels and usually of a light greyish or brownish colour, and when broken are found to contain a black mass of smut spores. These are very objectionable in seed wheat.

SCORE CARD.

	Points
Germinating power	20
Size and plumpness	20
Freedom from foreign seeds	20
Weight per bushel	15
Purity of variety	15
Hardness	10
Total	100

JUDGING CLOVER SEEDS.

In judging any of the clover seeds an acquaintance with the seeds of at least the more troublesome weeds is important since the presence of a considerable number of seeds of the comparatively harmless weeds would not be of much consequence, while the presence of a very few seeds of the most noxious weeds would be very objectionable. Comparative freedom from weed seeds is one of the most important points in judging any of the clover seeds.

COMMON RED CLOVER.—The points to be considered in judging Red Clover seed may be discussed as follows:—

1. *Size and Plumpness*—The seed should be of good size for the kind and should be plump and well filled, indicating good maturity and a capacity to produce vigorous plants.

2. *Colour*—In Red Clover seed there is a natural variation in colour from greenish yellow to dark purple with a more or less distinct difference between the dark seeds and the light seeds. If these are equal in size and plumpness and so forth (as they frequently are) it makes little difference whether there is a large or small proportion of dark seeds. There is, in the markets, however, a general tendency to favour samples containing a large proportion of dark seeds and there is possibly some justification for this. Whether the seeds be dark or light they should have a distinct lustrous surface, indicating freshness and vigour.

3. *Purity*—The seed should be pure, not only as to freedom from weed seeds but also as to freedom from other clover seeds, and in order to detect the latter kind of impurity the judge should be familiar with the other clover seeds which may closely resemble the light coloured seeds of Red Clover. These may be Sweet Clover, Alfalfa or Yellow Trefoil.

4. *Freedom from Deadish Brown Seeds*—All Red Clover seeds whether yellow or purple, have a tendency to turn to a brownish shade with age or with much exposure to the weather, and usually these brown seeds will not germinate so freely, nor produce such vigorous plants as the fresh, lustrous yellow and purple seeds.

SCORE CARD.

		Points
Size and plumpness		20
Colour	Lustre	15
	% Dark seeds	10
Purity		40
Freedom from deadish brown seeds		15
Total		100

ALFALFA—The same general principles used in judging Red Clover seed will apply in judging Alfalfa seed, but in Alfalfa seed the colour should be uniform, slightly greenish dull yellow, and there is a much greater variation in the shape of the alfalfa seeds than in the shape of Red Clover seeds. Partly matured seeds are more green in colour and often not so plump. In judging, this immaturity should be guarded against. There is also often found a proportion of brownish seeds, the result of immaturity and exposure, and these seeds either will not germinate or germinate weakly and so are objectionable.

In judging Alfalfa seed a close look-out must be kept for seeds of Sweet Clover or Yellow Trefoil, both of whch are much like Alfalfa in size and colour though different in shape.

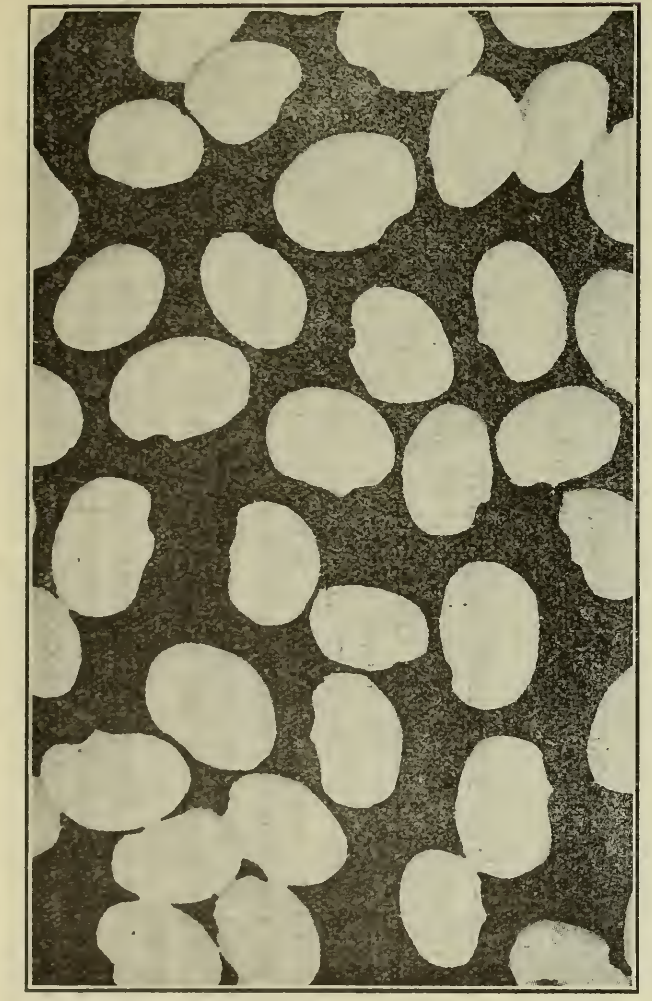
SCORE CARD.

	Points
Size and plumpness	20
Brightness of Colour and Lustre	20
Purity	40
Freedom from green or dead seeds	20
Total	100

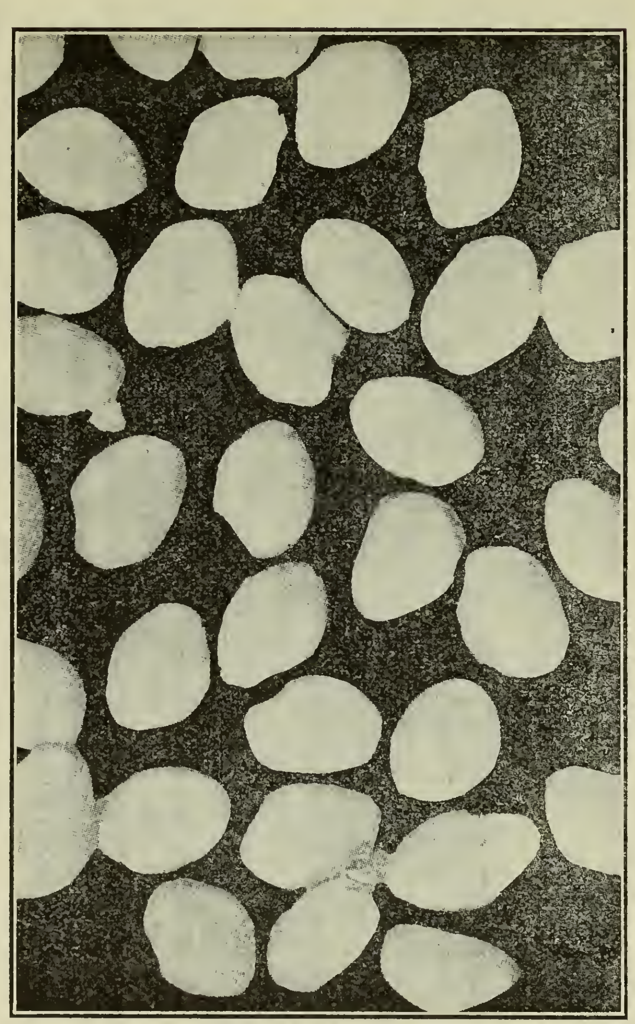
SWEET CLOVER.—The same general rules apply as in judging Alfalfa and Red Clover. Good Sweet Clover seed has a marked uniformity of colour and a little less lustre on the surface than Alfalfa seed. It also has a decided uniformity in shape which the Alfalfa does not have, and it has a distinct smell and taste different from the others. In the Sweet Clover there is less tendency to greenish and brownish immatured seeds, but the same general tendency to turn brown with age or exposure and this must be watched carefully in judging since either age or exposure tends to weaken germinating power.

SCORE CARD.

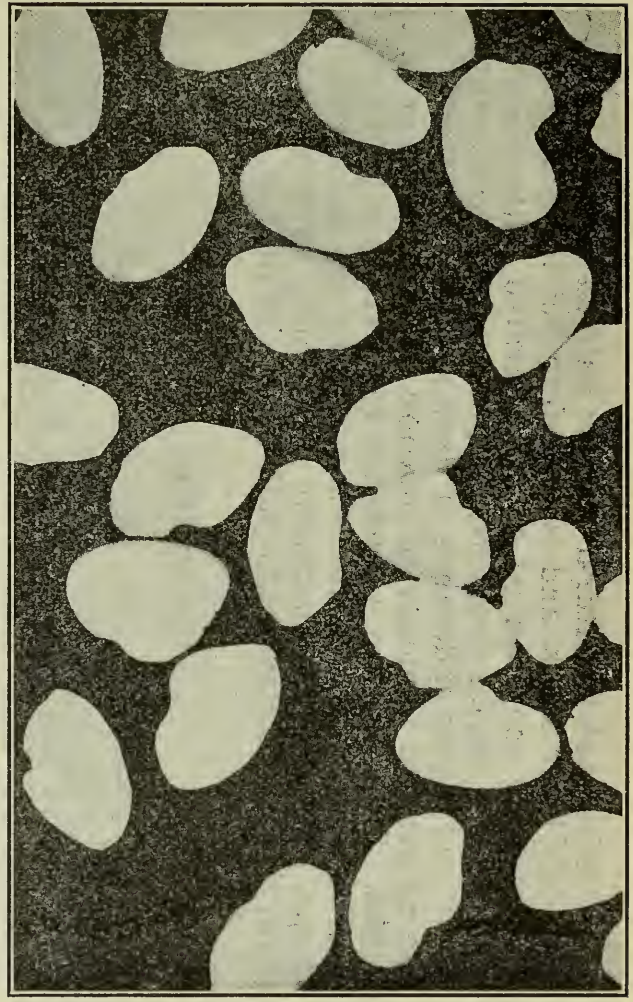
	Points
Size and plumpness	25
Colour	20
Purity	45
Freedom from brown seeds	10
Total	100



Yellow Trefoil (*Medicago lupulina*)
Magnified eight diameters.
(*After H. F. Roberts*).



Sweet Clover (*Meliltous alba*)
Magnified eight diameters.
(*After H. F. Roberts*).



Alfalfa (*Medicago sativa*)
Magnified eight diameters.
(*After H. F. Roberts*).

ALSIKE.—Alsike seed is naturally about half as large as Red Clover, Alfalfa or Sweet Clover seeds, and is therefore not likely to contain any mixture of these since they can be easily separated with screens. Good Alsike seed naturally varies from very light green to very dark bluish green in colour and a preponderance of dark seeds is generally favoured. There is just as great a tendency to mixture of weed seeds in Alsike as in other clovers. There is also a tendency to mixture with White Dutch clover since Alsike and White Dutch Clover seeds are almost identical in size and shape. They differ distinctly in colour, however, the White Dutch seed varying from clear light yellow to deep orange.

SCORE CARD.

		Points
Size and plumpness		20
Colour	Lustre	15
	% Dark seeds	10
Purity		45
Freedom from brown seeds		10
Total		100

JUDGING GRASS SEEDS.

In judging grass seeds especial care should be taken to determine the *size, purity* (i.e., freedom from weed seeds and cheap adulterant seed) and *germinating power,* as it is largely on these qualities that the success of our pasture and meadow husbandry depends.

TIMOTHY.—The points to be considered in judging Timothy seed may be discussed as follows:—

1. *Size and Plumpness*—Shrivelled seeds make weak seedlings. The seeds of our grasses are usually small, and there is only a limited supply of reserve food material in the seed available to the young seedling, hence the importance of large plump well developed seed, with an abundance of reserve food nourishing vigorous seedlings which keep ahead of the weeds and are not so subject to disease.

2. *Brightness of Colour* (*lustre*)—Brightness of colour (and in Timothy a beautiful silvery lustre) indicates that the seed has been harvested under very favourable weather conditions. Dark, stained or bleached seed indicates weather damage and consequently lowered germination power.

3. *Purity*—This is a most important point and you will note that 45 marks are allowed for it. By *purity* of seed is meant, freedom from weed seeds, foreign material, chaff, dirt, etc., and cheap adulterant grass seeds. Impurities are far more common in grass and clover seeds than in other crops, due to the fact that they are sown broadcast which prevents cultivation and it is rarely possibly to keep the fields free from weeds. The meadows from which the seed is harvested are usually the last crops in the rotation, hence weeds have had a chance to increase. It is very difficult to construct machinery which will do a thorough job of cleaning grass and clover seed from the small weed seeds often found mixed with them. Therefore, great care should be exercised in judging and buying grass seed as it is often through this source that our farms are contaminated by such noxious weeds as Oxeye Daisy, Cockle, Sow Thistle, etc.

4. *Freedom from Hulling*—Naked or hulless Timothy seed loses vitality quickly, and should be discriminated against.

SCORE CARD.

	Points
Size and plumpness	20
Brightness of colour (lustre)	20
Purity	45
Freedom from hulling	15
Total	100

JUDGING POTATOES.

In preparing to judge potatoes one should first make himself familiar with the popular types and the more common varieties, also with the evidences of disease as these may be seen in the tubers.

Potatoes are often shown in type classes such as round white, long white, rose coloured, and so forth; or Rural type, Cobbler type, Green Mountain type, and so forth. They are also frequently shown in variety classes such as Irish Cobbler, Carman No. 1, Early Ohio, Rural New Yorker and so forth.

The desirable type for the market at present is a smooth white potato of fair size (not too large), with two dimensions nearly equal and the third dimension considerably less (flat round). This is the Rural type and includes Rural New Yorker, Dooley and similar varieties. The Green Mountain is of a slightly more rectangular or oblong shape but is also quite popular. The Cobbler is of a roughly round but rather thick shape and usually has quite a large depression on the stem end, and rather deep eyes. Although this shape is not so desirable as that of the Rural type still the Cobbler variety is very popular because of its earliness, productiveness and good quality.

The important points to consider in judging are:

1. Trueness to type or variety. 2. Uniformity in size, shape and colour. 3. Smoothness. 4. Size. 5. Freedom from disease. 6. Quality.

The first three points need no further explanation.

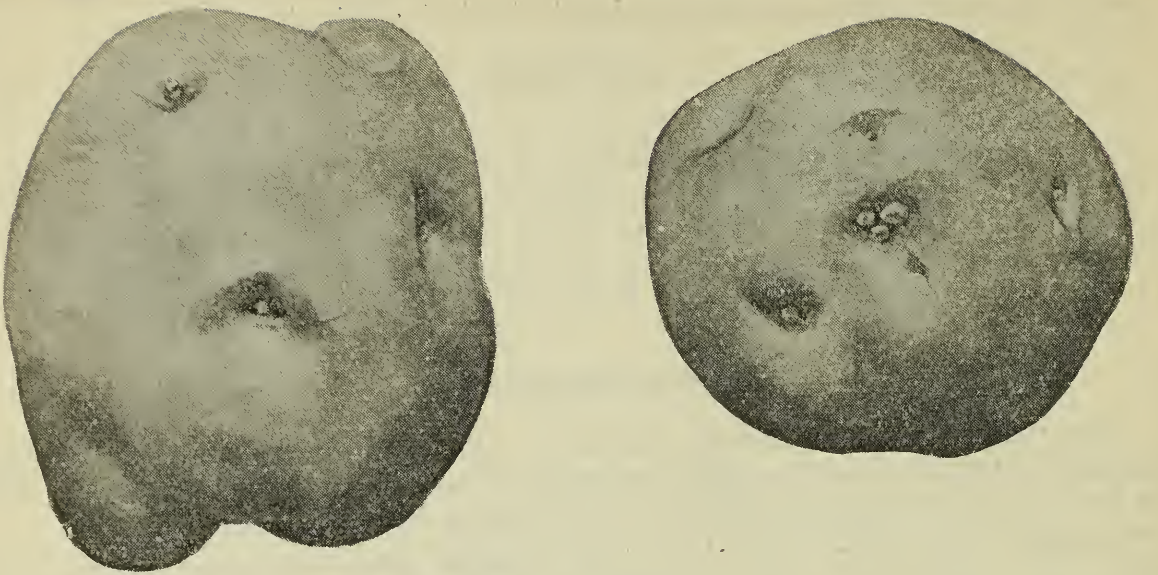
Very large potatoes are often rough, sometimes hollow and usually of poor quality. Even when sound and good they do not look so well on the table and a single potato is often more than is required for a meal by an individual.

Disease is indicated by scabbiness or small black specks or cloudy, dark spots on the skin; by discoloured portions or streaks in the interior; or by actual decay. It is also sometimes indicated by a softness at the point where the stem is attached. Good sound potatoes usually have a very small portion of the stem adhering. If this is absent the point should be examined carefully for the beginning of disease.

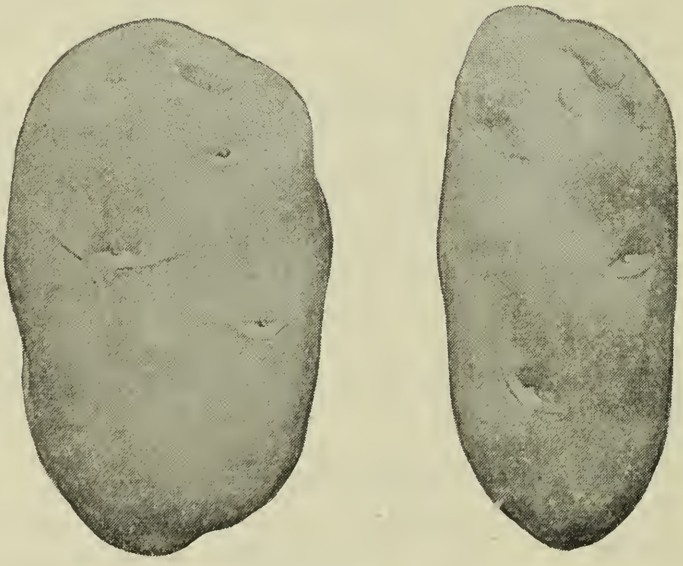
Quality is indicated by a rather uniform white interior colour and the absence of watery streaks in the interior, and by an abundant frothiness when the two halves of a freshly cut potato are vigorously rubbed together.

To detect disease and to determine quality one or two potatoes in each entry may be cut. In judging competitions where it is not possible to allow each competitor to cut a fresh potato, a single potato may be cut and each competitor cut off a fresh slice of it for examination.

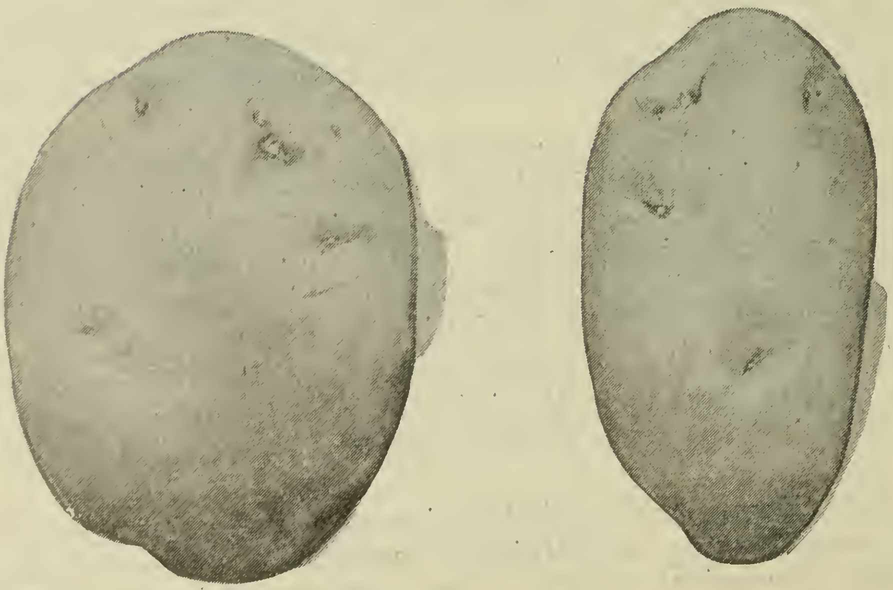
GOOD TYPES OF POTATOES.



IRISH COBBLER.



GREEN MOUNTAIN.



RURAL NEW YORKER.

IRISH COBBLER TYPE—

Tubers—Roundish, skin creamy white.

Sprouts—Base, leaf scales and tips slightly or distinctly tinged with reddish violet or magenta. In many cases the colour is absent.

Flowers—Light rose-purple, under intense heat may be almost white.

Varieties—Early Dixie, Early Eureka, Early Petoskey, Early Standard, Early Vicktor, Extra Early Eureka, Flourball, Irish Cobbler, Potentate, Bells Deposit.

GREEN MOUNTAIN—

Tubers—Moderately to distinctly oblong, usually broad, flattened, skin a dull creamy or light russet colour, frequently having russet-brown splashes toward the seed end.

Sprouts—Base, leaf scales, and tips creamy white, or base usually white, occasionally tinged with magenta; leaf scales and tips tinged with lilac to magenta.

Flowers—White.

Varieties—Bethel Beauty, Blightless Wonder, Carman No. 1, Clyde, Delaware, Empire State, Farmer, Freeman, Gold Coin, Green Mountain, Green Mountain Jr., Gurney's White Harvest, Keystone, Late Blightless, Long Island Wonder, Norcross, Pride, Snow, State of Maine, Uncle Sam, White Mountain.

RURAL NEW YORKER—

Tubers—Broadly round-flattened to short oblong, or distinctly oblong-flattened, skin creamy white, or deep russet.

Sprouts—Base dull white; leaf scales and tips violet-purple to pansy violet.

Flowers—Central portion of corolla deep violet, with the purple growing lighter toward the outer portion; five points of corolla white, or nearly so.

Varieties—Arcadia, Carman No. 3, Dooley, Great Divide, Jackson White, Late Vicktor, Lily White, Million Dollar, Noxall, No. 9, Ohio Wonder, Peerless (Bresee's No. 6) or Boston, Prosperity, Rhind's Hybrid, Rural New Yorker No. 2; Sir Walter Raleigh, White Giant, White Swan, Late Petoskey, (Rural Russet) Russet (Dibble's).

SCORE CARD.

	Points
Purity of variety	10
Uniformity	10
Size	10
Smoothness	10
Shape	5
Nature of skin	5
Colour	10
Freedom from disease	15
Quality	25
Total	100

JUDGING TURNIPS.

In preparing to judge turnips one should first make himself familiar with the more popular types and varieties. For shipping or table purposes a smooth, globe-shapod and clearly purple-topped root with a rather small neck is preferred, and the size should run from about four to six inches in diameter.

If the roots are being judged for feeding purposes the same general type is preferred, although an oblong shaped turnip is not objected to, and the roots may be of somewhat larger size providing they are smooth, sound and good in quality.

The main points to be considered in judging are:

1. Size and uniformity of roots. 2. Trueness to type or variety. 3. Smoothness. 4. Freedom from disease. 5. Quality.

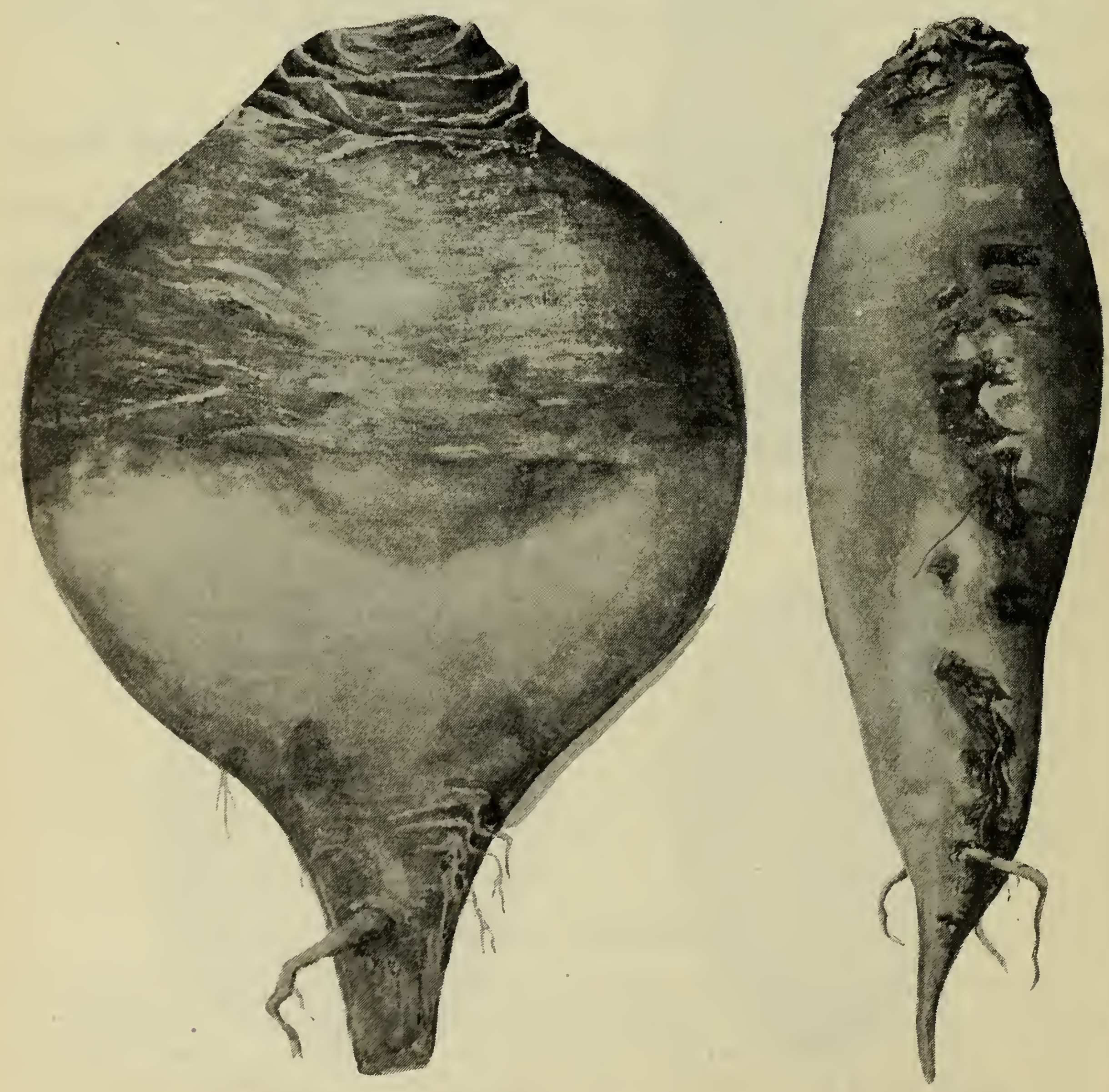
The first two points need no further discussion.

Roots grown in heavy or hard soil are often off-shape and develop a coarse rootiness which gives them a bad appearance and sometimes poor quality, hence the necessity for smoothness.

Disease, or a tendency to disease, may result from undue bruising or from hollowness, but disease is not common in turnips.

Quality is indicated by a uniform light colour in the interior, by crispness and the lack of fibre, and by the absence of watery streaks in the interior (often called water core). Roots sown early in the spring and allowed to grow until the end of the season often develop a distinct fibrousness and poor quality.

GOOD TYPE OF SWEDE TURNIP AND MANGEL.



CANADIAN GEM TURNIP.   LONG MANGEL.

JUDGING MANGELS.

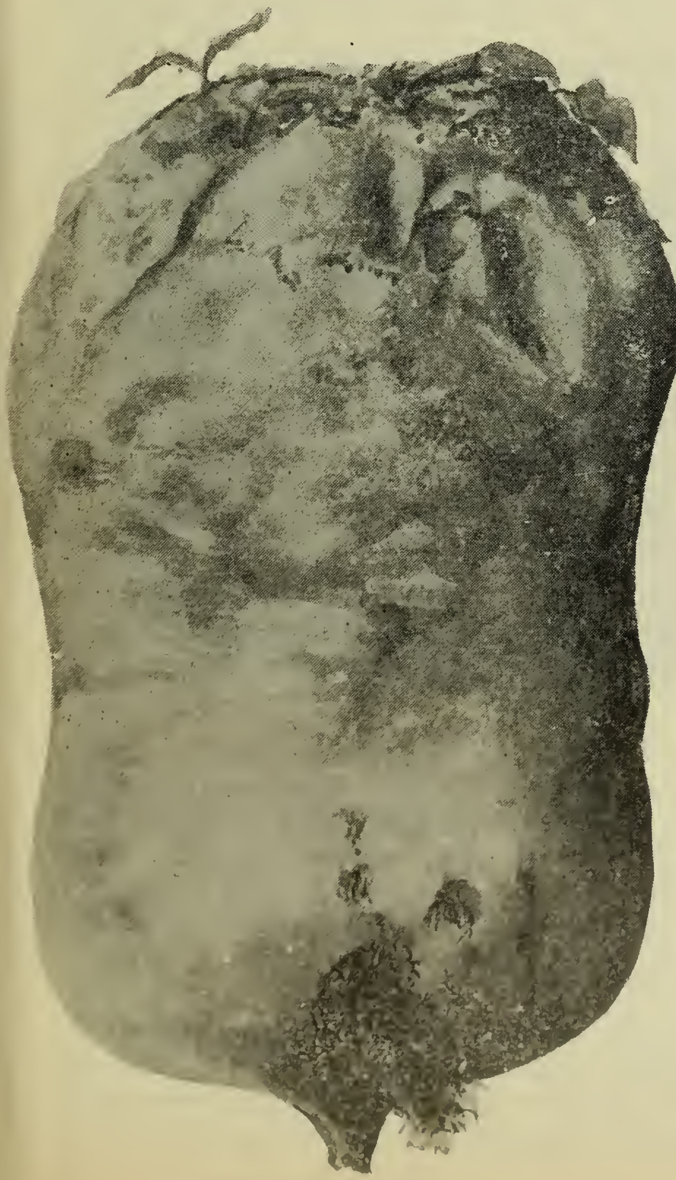
The same rules followed in judging turnips will hold good in judging mangels excepting that greater care should be taken to detect the evidences of disease since mangels are more easily injured by bruising and on these bruised spots may quickly develop mould and afterwards decay. There is also a greater tendency to hollowness especially near the crown.

The main types are the long red, the yellow intermediate (including the long-oval and tankard shapes) and the white sugar mangel. The long red is not now nearly so popular as formerly and the other two are the ones generally grown.

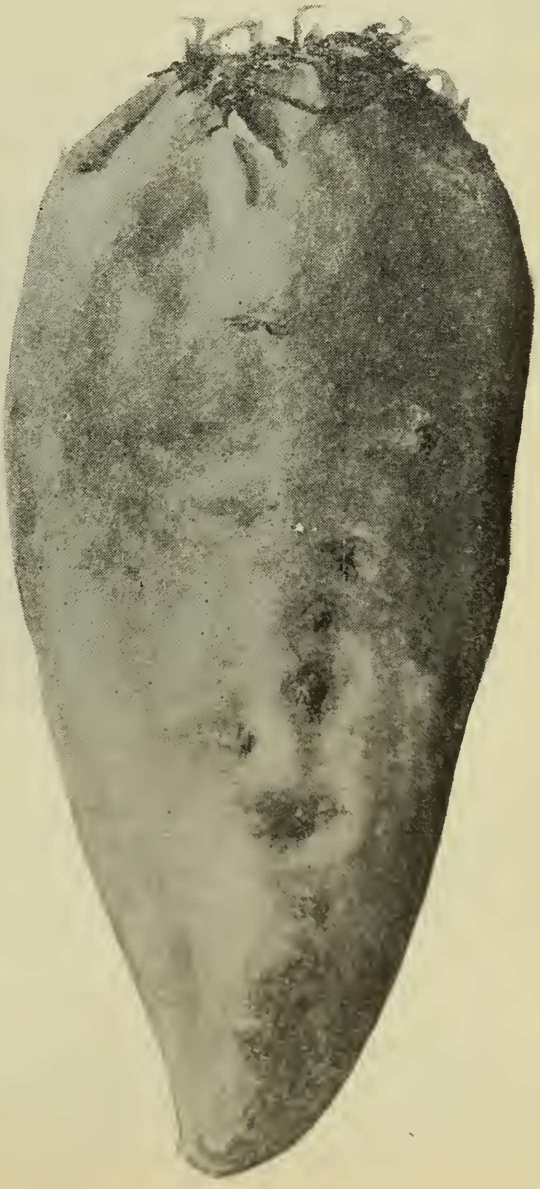
Where mangels are all judged in one class the judge should be careful not to place too high a value on the supposed sweetness of the sugar mangel. As a matter of fact, the sugar mangels are usually only very slightly sweeter than the intermediate mangels. This has been determined by definite analysis.

SCORE CARD—JUDGING ROOTS.

	Points
Size and uniformity of roots	30
Trueness to type or variety	20
Smoothness	10
Freedom from disease	15
Quality	25
Total	100



TANKARD MANGEL.



INTERMEDIATE MANGEL.

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO

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POTATOES

by

W. J. Squirrell and A. H. MacLennan

IMPORTANCE OF THE CROP

The importance of the potato is not always generally realized either by the producer or the consumer. This crop ranks second only to wheat as a human food. No single crop either in New or Old Ontario is grown on a greater number of farms than potatoes. In the average of the five year period, 1923 to 1927, inclusive, there were 162,191 acres of potatoes grown in Ontario with an average total production of 18,360,979 bushels. Potatoes provide one of the cheapest forms of human food and are used in Ontario almost as extensively as bread. At the present time Japan, whose chief food product is rice, is spending large sums of money investigating the growing of the potato for Japanese conditions.

A Field of Irish Cobblers grown from Certified Seed.

Composition and Uses.

Potatoes are rich in starch and form one of the chief commercial sources of this product. When used alone they form an unbalanced ration but in conjunction with foods rich in protein, such as meat, fish, etc., they become an important factor in a well balanced diet. Chemical analysis show that cooked potatoes (peeled) contain 75.5 per cent. water; 2.5 per cent. protein; 20.9 per cent. carbohydrates; .1 per cent. fat; and 1.0 per cent. ash. An analysis of raw potatoes (peeled) showed a slightly higher water content and a slightly less carbohydrate content than cooked potatoes, peeled. The carbohydrates are made up chiefly of starch, sugar and a small amount of crude fibre. The analysis made by the Chemical Department of the Ontario Agricultural College of eighty-one lots of potatoes of different varieties from different soils and localities in Ontario and New Brunswick showed there was a variation in percentage of dry matter from 16.4 to 26.6; of protein from 1.5 to 2.9; and of starch from 9.6 to 20.7. The average amount of starch in potatoes grown on sandy loams and on light sandy loams was 16.0 per cent., and on heavy clay loams 16.1 per cent. The results, therefore, showed little difference in starch content of potatoes grown on light and heavy types of soil. A test of a number of different varieties of potatoes grown under similar conditions of soil and climate showed wide differences in chemical composition. In experiments conducted by the Department of Field Husbandry over a period of several years to determine the table quality of potatoes, results showed that the table quality was more influenced by variety than by locality, soil or climate. A high percentage of carbohydrates or starch causes potatoes to be dry or mealy, a high percentage of protein to be waxy and a high percentage of water to be wet and soggy.

In the Province of Ontario an average crop of potatoes removes from an acre of land approximately 25 pounds of nitrogen, 37 pounds of potash and 8 pounds of phosphoric acid. An average crop of potatoes removes less of the fertilizing constituents from the soil than an average crop of mangels or corn.

The chief use of potatoes in the Province of Ontario is for the production of human food. These potatoes are prepared and used in many ways. In the process of peeling raw potatoes lose approximately 20 per cent. of their weight. Potatoes fed to farm stock in Ontario are confined largely to peelings, culls and the surplus of old potatoes on hand, except when prices are low, then a considerable percentage of the crop is fed. As the result of experiments in feeding hogs Fjord of Denmark found that 400 pounds of cooked potatoes equalled 100 pounds of mixed grains; Henry of Wisconsin, that 442 pounds of cooked potatoes equalled 100 pounds of corn meal; and Potter of Oregon, that 360 pounds of steamed or 552 pounds of raw potatoes equalled 100 pounds of barley. German economists estimate that 40 per cent. of their potato crop is fed to stock; 28 per cent. is used for human consumption; 12 per cent. for seed; 6 per cent. in the manufacture of alcohol; 4 per cent. in the manufacture of starch and related products and 10 per cent. decay. It is likely that in future a larger percentage of the Ontario potato crop will be fed to stock and used in the manufacture of commercial products.

CLIMATE AND SOIL.

The potato thrives best in a rather cool climate where there is a sufficient supply of moisture for its development. Wet summers and extremely hot weather are detrimental to the best development of the potato. In each of the past twenty-eight years meteorological records have been taken by the Department of Physics of the Ontario Agricultural College. These records show the total amount of precipitation in each of the five growing months, May to September, 1927, and for the average of the past twenty-eight year period in the table given below:—

Period	May	June	July	Aug.	Sept.	Total
	inches	inches	inches	inches	inches	inches
1927 (1 year)	4.54	2.92	8.81	1.13	1.53	18.93
1900-1927 (28 years)	3.05	2.89	3.70	3.13	2.74	15.51

Extensive investigations carried out in the United States indicate that the best potato growing areas have a precipitation of twelve to eighteen inches during the period between planting and harvesting late potatoes. It will be noticed in the above table that the amount of rainfall in the five growing months at Guelph comes within the limits of precipitation which indicate the possibility of maximum yield. The average total precipitation at Guelph for this period does not vary greatly from that of a large part of the Province of Ontario. It should be remembered that good cultivation is one of the best agencies for conserving and regulating the soil moisture supply.

Potatoes are grown on many types of soil but give their best results on rich sandy loams where there is a good moisture supply. The greatest yields of potatoes should not be expected on very light sandy or very heavy clay soils, poorly drained soils or on soils lacking in fertility or organic matter.

ROTATION.

In considering a rotation for the potato crop the grower should not only consider the needs of this crop but also the requirements of the other crops following potatoes. The success attained by the farmer in all lines of crop production is largely measured by the choice of crops in his rotation. In those sections where potatoes are extensively grown a three to five year rotation is generally practised and here legumes play an important part. The common rotation in many parts of Ontario is potatoes, grain and clover. The first crop of clover is usually cut for hay and the second crop ploughed under in the late summer or early autumn. In rotations lasting four or five years the clover is used for hay for one or two years or pasture for a year or two. A three year rotation consisting of potatoes, grain and sweet clover or alfalfa has been successfully used in a number of the principal potato growing sections of the Province. Potatoes require a large amount of organic matter in the soil and it is of first importance that a good legume be one of the crops in the rotation. Rotation experiments at Guelph indicate that red clover, sweet clover and alfalfa sod form an excellent preparation for the potato crop. The potato is one of the very best of cleaning crops and thorough cultivation of the soil during the growing of the crop leaves the land in excellent condition for the crop which follows.

Few plants suffer more from virus diseases than potatoes and the growing of this crop in a definite rotation is one of the best means of minimizing the injury from these diseases.

MANURE AND FERTILIZERS.

Barnyard manure is one of the most valuable sources of plant food. It should be remembered, however, that it is quite variable in composition depending on whether it is horse, cow, sheep, hog or poultry manure and also on the care taken to conserve the liquid and solid excrement. An application of twenty tons per acre of good barnyard manure would add approximately 200 pounds of nitrogen, 100 pounds of phosphoric acid and 200 pounds of potash to the soil. If all this were available for the growing potato crop it would be more than sufficient to produce a three hundred bushel yield per acre.

When fresh stable manure is used it may be applied to the land after it has been fall ploughed and cultivated. After spreading the manure the land is thrown into ridges about thirty inches apart with a double mould board plough. The manure contained in the ridges is protected over winter and the land left in this condition until time for preparing the seed-bed in the spring. Leaving the soil in the ridges over winter exposes the largest amount of surface to the action of the elements and provides the best possible surface drainage in the spring. Some potato growers apply barnyard manure on sod land during summer, autumn, winter or in spring and plough the land just before planting time. When the manure is applied to land in the spring unless it is well rotted it has a tendency to increase the amount of scab. Because of this many growers prefer applying barnyard manure to the crop preceding potatoes. Barnyard manure in addition to being a valuable source of soil fertility is also one of the chief sources of organic matter.

Except in the case of two or three highly specialized crops no cultivated crop receives more artificial fertilizers than the potato and few crops respond more readily to their application.

The nitrogen in artificial fertilizers promotes the vegetative growth of the plant and a good supply of this element is usually indicated by a deep green color in the foliage of plants. A deficiency of nitrogen in the soil is indicated by the stunted growth of the plant. A too liberal use of nitrogen produces an excess of top and delays maturity.

The phosphates in artificial fertilizers stimulate root growth and hasten maturity.

Potash is an important element in artificial fertilizers because it produces an abundance of carbohydrates such as starch and the potato crop is dependent on a large supply of this element.

A sufficient supply of all of the above elements in an available form is necessary for maximum production of the potato crop. Whether the soil is deficient in one or all of the above elements can only be determined by field trials.

To use artificial or commercial fertilizers most intelligently the farmer should study his own soil needs through simple plot tests and obtain the general information available on the subject of fertilizers in the annual reports of the Ontario Agricultural and Experimental Union and the bulletins of the Department of Chemistry of the Ontario Agricultural College.

The Department of Chemistry of the Ontario Agricultural College in experiments conducted on sandy loam types of soil in a number of the potato growing districts of Ontario found a fertilizer combination of 4-12-4 or 3-10-5 gave good results where no barnyard manure was used or clover ploughed under; a 2-12-6 where some barnyard manure was used; and a 0-12-5 where a good application of barnyard manure was given and a clover sod ploughed under. Results showed that it was economical to apply 500 to 600 pounds per acre of these fertilizer combinations where conditions warranted it. Under some conditions as much as 1000 pounds per acre may be used with profit.

It is always well to remember that the problem presented by each type of soil varies and the potato grower should modify the quantities of fertilizers and manure to suit his requirements. Manuring and fertilizing is secondary to soil and climate and when these are particularly unfavorable no skill in adding manures and fertilizers will insure a maximum yield. The use of fertilizers and manures will not amend the results of poor seed-bed preparation and poor cultivation.

Preparation of the Soil.

Fall ploughing is recommended for the potato crop. Where this is followed in the late autumn by ridging, it insures the most complete decay of the sod and exposes the soil to the agencies causing disintegration. The depth of ploughing will vary with the type of soil, depth of surface soil and character of the sub-soil. Where the surface soil is deep it is ploughed to a greater depth than where it is shallow. On soils well adapted to potato growing the depth of ploughing should be from five to seven inches. The spring preparation of the soil where the land has been left in ridges over winter consists of thoroughly cultivating and harrowing the land. It is a common practice with some farmers to apply manure in the late winter or early spring and spring plough the land. This requires a more thorough spring preparation of the seed-bed than where the land has been fall ploughed. The aim in soil preparation should be to provide for the potato a deep mellow seed-bed and as far as possible have the organic matter well decomposed before planting.

SEED POTATOES.

The selection of the best potato seed stock is just as important as the selection of the best seed of different varieties of grain.

Experiments at Guelph indicate that immature potatoes have a greater seed value than matured potatoes.

In the average of an experiment conducted for a period of four years with two early, two medium and two late maturing varieties of potatoes it was found that potatoes planted on the average date of July 12th and the next year used for seed produced 219.5 bushels as compared with potatoes planted on the average date of May 31st and the next year used for seed which produced 192.4 bushels of potatoes per acre. The value of immature potatoes for seed is further evidenced in the results presented in the following table:—

Source	Average Yield of Potatoes per Acre (Bushels)										
of Seed	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	Ave.
Northern Ontario	142.8	134.6	292.6	168.1	187.2	195.3	209.3	169.7	217.1	189.6	190.6
Southern Ontario	123.9	128.5	279.8	163.9	183.2	187.7	198.8	162.4	198.8	185.4	181.2

Uniform and Vigorous Growth from Seed of Selected Hills.

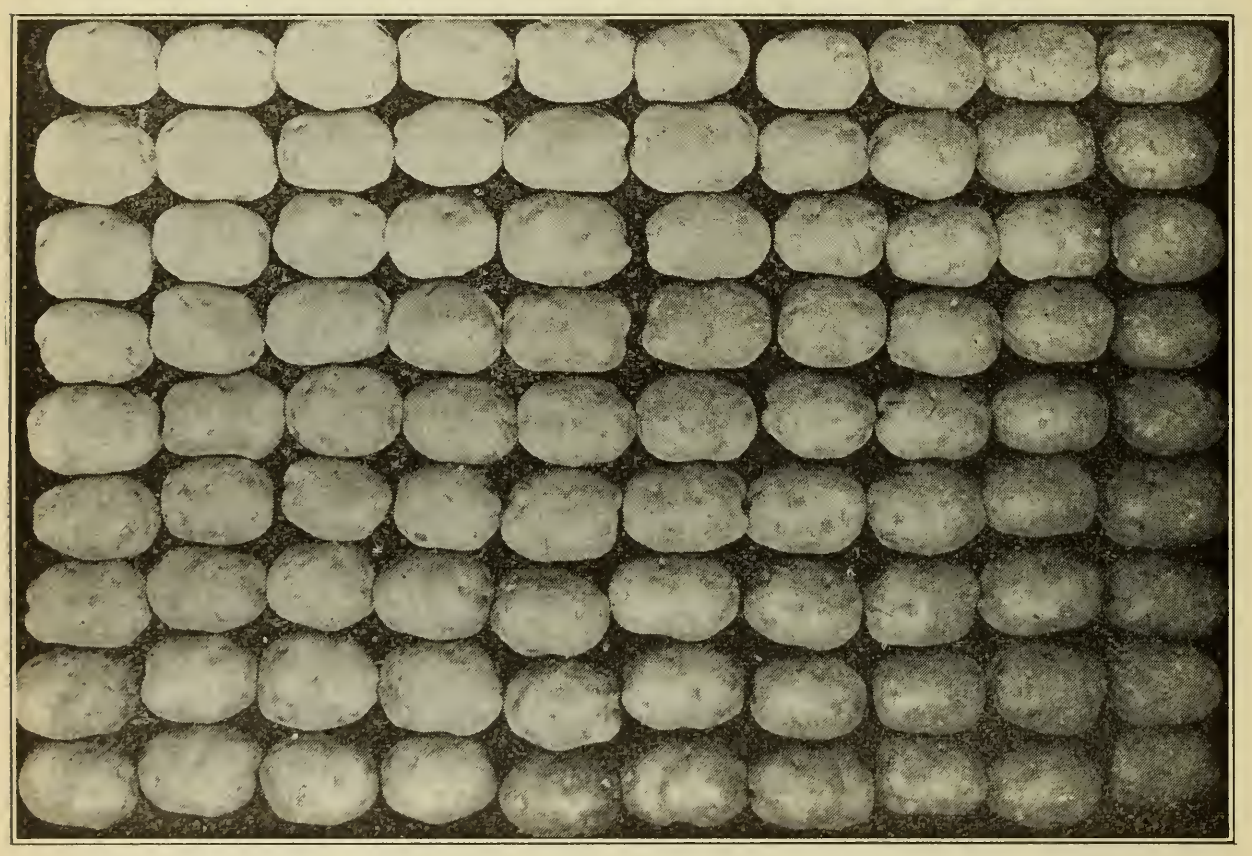
The average figures in this table summarized the results of co-operative experiments on 630 farms, most of them in Old Ontario. It will be noticed that in every one of the ten years the Northern grown seed produced a higher yield per acre than seed which was grown in Southern Ontario, the average difference for the whole period being 9.4 bushels per acre. In each of the years in which the experiment was conducted both the Northern and Southern grown seed was obtained from inspected fields and was comparatively free from disease of all kinds.

Farmers, especially when potatoes are a good price, sometimes use small potatoes for seed. If these are selected indiscriminately from the potato seed bin this is not a good practice. These small potatoes may have come from hills which had few and only small potatoes or the small size may have been due to disease. The farmer can do much to improve the yield, quality and uniformity of his crop if, when the plants are in bloom, he stakes enough good hills to provide seed for the following year. These hills should be dug and the potatoes stored separately from the general crop. In an experiment conducted for a period of fifteen years (1913 to 1927 inclusive) potatoes of the Davies' Warrior variety from the outstanding selected hills produced yields as follows:—No. 5 Hill, 217.4 bushels; No. 2 Hill, 192.1 bushels; No. 1 Hill, 180.6 bushels; and No. 8 Hill, 178.0 bushels per acre. These selected hills all produced greater yields per acre and a higher percentage of marketable potatoes than the ordinary run of seed stock of the same variety.

The potato is not a seed but a tuber and usually requires more frequent change of planting material than is the case with most other crops. It will often be found advisable to obtain certified seed of the best varieties where these latter have been produced under conditions which provide immaturity of seed and contain the minimum of disease.

VARIETIES.

One of the most important questions for the potato grower to decide is the choice of variety to grow. In choosing the variety the grower should keep in mind yield, quality, adaptability to growing in the district, and suitability for the market.



A Well Selected Lot of Green Mountain Potatoes.

The most desirable type for the market at present is a smooth white potato of fair size (not too large) with two diameters nearly equal and the third dimension considerably less (flat round).

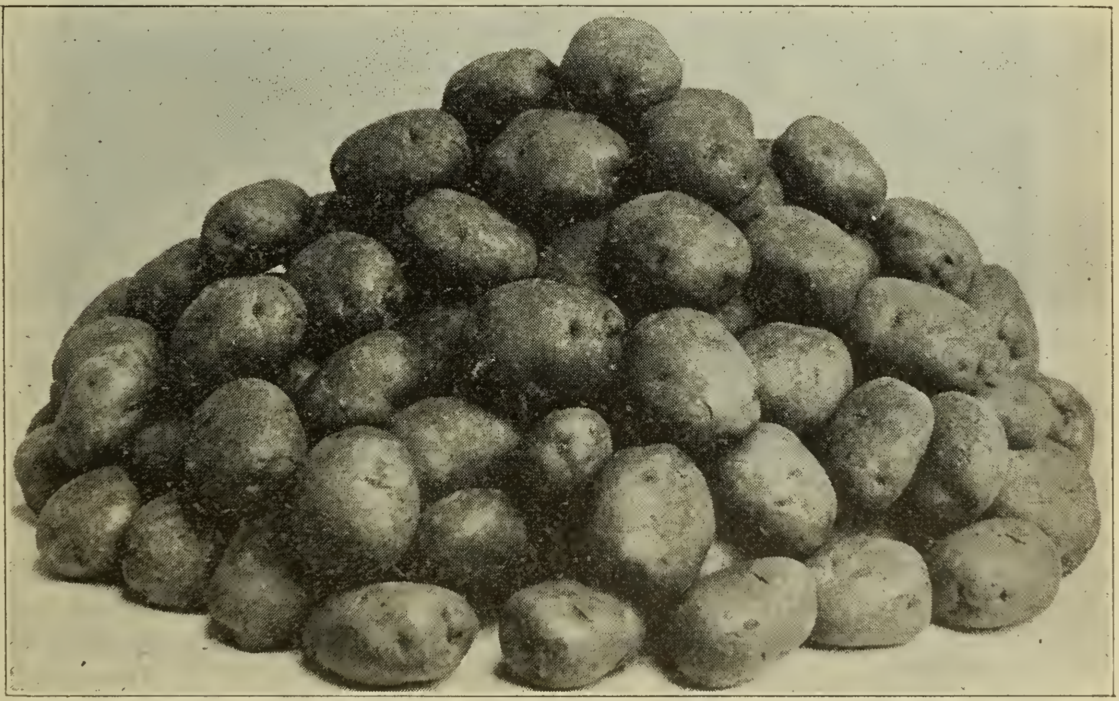
There are still too many varieties of potatoes grown on the farms of Ontario. It is not possible to obtain maximum yield, the best quality and a uniform product for market when a large number of varieties are grown in a district.

In all 445 varieties of potatoes have been under experiment at the College. Most of these varieties have been grown for at least 5, some for 10, 15, 20 and even 30 years. It is not the purpose of this bulletin to discuss in detail the results obtained from testing this large number of varieties but only three which have proven to be of greatest economic importance in the Province of Ontario. These are the Green Mountain, Rural New Yorker and Irish Cobbler varieties.

Green Mountain. The tubers are moderately to distinctly oblong, usually broad, flattened; skin a dull cream or light russet color, frequently having russet brown splashes toward the seed end. The sprouts are usually white occasionally tinged with magenta, while the leaf scales and the tips are tinged with lilac to magenta. The flowers are white.

In variety tests in the experimental field at Guelph covering a long period of time the Green Mountain variety was one of the best yielders. In experiments to determine table quality and which considered mealiness, flavor and appearance this variety ranked among the best. The eyes of the Green Mountain are fairly shallow and it seems to possess only medium disease resistance. In co-operative experiments covering a ten year period, this variety, tested by 1162 farmers in all the counties and districts of the Province of Ontario gave an average yield of 203.9 bushels compared with the Irish Cobbler, 173.3 bushels per acre. The percentage of small potatoes (potatoes less than 1-½ inches in diameter) of the Green Mountain variety was 9.6 and of the Irish Cobbler 12.7. The results of these co-operative tests run in the same direction as those conducted in the experimental plots at Guelph and show that the Green Mountain produces a somewhat higher percentage of marketable potatoes than the Irish Cobbler variety. The Green Mountain is a medium late maturing variety.

Varieties of the Green Mountain group are:—Green Mountain, Bethel Beauty, Blightless Wonder, Carman No. 1, Clyde, Delaware, Empire State, Farmer, Freeman, Gold Coin, Green Mountain Jr., Gurney's White Harvest, Keystone, Late Blightless, Long Island Wonder, Norcross, Pride, Snow, State of Maine, Uncle Sam, White Mountain.



A Good Selection of the Dooley Variety.

Rural New Yorker. The most common variety of this type in Ontario is the Dooley. The tubers are broadly round flattened to short oblong, or distinctly oblong flattened; skin creamy white or deep russet; sprouts at the base dull white in color; leaf scales and tips violet purple to pansy purple. The central part of the corolla of the flower is deep violet in color with the purple growing lighter toward the outer sections; five points of the corolla are white or nearly so.

In the average results of the experiments at the College and in the co-operative experiments over Ontario the Rural New Yorker has not yielded quite as well per acre as the Green Mountain variety. It seems, however, to be well adapted to those sections of the Province where the summers are the warmest. The quality of the Rural New Yorker variety is good. The Rural New Yorker is medium late in maturing and has shallow eyes. This variety proved to be one of the best in disease resistance of the varieties tested at Guelph. The Rural type produces its tubers after the plants are well grown.

Varieties of the Rural New Yorker group are:—Rural New Yorker, Arcadia, Carman No. 3, Dooley, Great Divide, Jackson White, Late Vicktor, Lily White, Million Dollar, Noxall, No. 9, Ohio Wonder, Peerless (Bresee's No. 6) or Boston, Prosperity, Rhind's Hybrid, Rural New Yorker No. 2, Sir Walter Raleigh, White Giant, White Swan, Late Petoskey (Rural Russet), Russet (Dibble's), Roxbury.

Irish Cobbler. The tubers of this variety are roundish to roundish flattened or slightly oblong flattened; the stem end is usually deeply notched and the tuber has a shouldered appearance at the base. The tips of the sprouts are slightly or distinctly tinged with reddish violet or magenta. In some cases the color is absent. Flowers are a light rose purple and under hot summer conditions may become almost white. The Irish Cobbler is one of the best early maturing varieties tested at Guelph and in the co-operative experiments over Ontario. This variety which possesses fairly deep eyes is one of the most resistant against disease. Its table quality is good and it is one of the best keepers of the early maturing potatoes. Experiments in the storage of potatoes show that it keeps as well as most of the late maturing varieties.

A Good Selection of the Irish Cobbler Variety.

Varieties of the Irish Cobbler group are:—Irish Cobbler, Early Dixie, Early Eureka, Early Petoskey, Early Standard, Early Vicktor, Extra Early Eureka, Flourball, Potentate, Bells Deposit.

Note—Description of Varieties and Group Classifications from "The Potato" by Wm. Stuart.

TIME OF PLANTING.

The time at which potatoes should be planted is controlled by a number of factors, climatic conditions at planting time being one of the chief of these. In the main it may be said that potatoes for early market should be planted just as soon as danger from late spring frosts is passed. The following table gives the average results of planting the Irish Cobbler, an early maturing, and the Green Mountain, a late maturing variety, on each of five different dates for a period of seven years:—

Variety	Average Results, 7 Years, 1918-1924		
	Date of Planting	Yield per Acre (Bushels)	
		Marketable	Total
Irish Cobbler	May 6th	197.5	227.4
	" 20th	182.2	211.8
	June 3rd	165.4	190.0
	" 17th	151.7	179.1
	July 1st	101.5	129.2
	" 15th	53.7	81.4
Green Mountain	May 6th	233.3	272.1
	" 20th	215.6	250.2
	June 3rd	194.3	224.1
	" 17th	177.1	213.2
	July 1st	98.8	130.9
	" 15th	24.3	46.7

This experiment was conducted in duplicate and is the average of using both Northern and Southern grown seed of each variety. The greater part of the late or main crop potatoes are planted in Ontario between the 15th of May and the 1st of June. The results of this experiment would indicate, where the season and labor conditions permit, that larger yields per acre would be obtained if the main crop potatoes were planted somewhat earlier than is the usual practice. The best table quality was obtained from earliest plantings, when the potatoes were matured at time of harvest.

SEED POTATOES EXPOSED IN DIFFERENT WAYS FOR THREE WEEKS BEFORE PLANTING.

An experiment was conducted for five years in succession in which potatoes were evenly divided into different lots and placed in varying degrees of light and heat for three weeks before they were planted. Some were placed in a dark cellar, others in the window of the cellar, others on the barn floor, others in the greenhouse immediately under the glass and others in the open air. Two varieties were used in the experiment. The different lots of each variety were made up of the same weight and the same number of tubers. Potatoes exposed in a dark cellar grew long, tender, light colored sprouts, while those in a warmer temperature and in the light produced short, green colored sprouts. One-half of the potatoes kept in the dark cellar were planted with the sprouts removed and the other half with the sprouts still attached to the tubers. The table below gives the average percentage marketable and the yield of marketable as well as the total yield for the ten tests in the five years for each of the six treatments:—

Places where Potatoes were kept for twenty-one days before planting.	Average Percentage Marketable	Average Bushels per Acre per Annum	
		Marketable	Total Yield
1. In barn in light (sprouts on)	77.9	187.1	221.1
2. In root cellar in light (sprouts on)	74.4	173.8	210.6
3. In root cellar in dark (sprouts on)	74.1	169.4	206.0
4. In greenhouse in light (sprouts on)	59.8	134.6	189.3
5. In root cellar in dark (sprouts off)	63.1	130.5	177.3
6. In open air (sprouts on)	58.2	62.9	107.3

Late potatoes which were placed on the barn floor in the latter part of May and allowed to remain there for three weeks after which they were planted whole with the short sprouts attached gave better results than tubers submitted to any other exposure in total yield and in yield of marketable potatoes. The potatoes which were kept for three weeks in a dark root cellar and which were carefully planted with the tender sprouts attached gave an average yield of 28.7 bushels more than similar potatoes from which the sprouts had been removed. These results show that seed potatoes from which sprouts have been removed in the spring before planting are considerably weakened for crop production. The results also show that if seed potatoes are allowed to sprout in the spring their value depends principally upon the conditions under which the sprouts are allowed to develop before the time of planting. Tubers which were exposed to the open air were injured considerably by changes in temperature.

When the whole potato is exposed to the light a very few of the eyes start to grow and these are generally situated at or near the seed end. The total resources of the potato are largely devoted to the development of the few sprouts which start first and many of the eyes thus remain in a dormant condition. In the early stages of growth the food material of the young sprouts seems to be drawn from that part of the tuber which is the greatest distance away from the new growth.

Seed potatoes placed in shallow trays and stored for a short period before planting in a room moderately warm, well ventilated and lighted have given excellent results. By this process the sprouts produced will be short, dense, full of color and strong enough to withstand handling at planting time. The young sprouts will develop buds near the potatoes which probably accounts for the increase in productiveness. Sprouted tubers hasten the season of growth producing strong healthy plants which are often likely to escape the worst attacks of blight.

The sprouting method mentioned above is used principally in growing the extra early potato crop.

PLANTING SETS OF DIFFERENT SIZES WITH ONE EYE IN EACH SET.

This experiment consisted of six separate plots in which potato sets of 1/16, 1/8, 1/4, 1/2, 1 ounce and 2 ounces in weight were planted under similar conditions. No set contained more than one eye. The sets were planted one foot apart in the row. There was thus exactly the same number of sets used in each of the plots. The experiment was conducted in duplicate in each of five years, two varieties being used each season. The potato sets were planted to a depth of about four inches and flat cultivation was used throughout. The following table gives the average of five years' results in testing potato sets of six different sizes:—

Size of Sets Planted.	Eyes per Set	Amount of seed used per Acre (bushels)	Average results for 5 years (10 tests)			
			Percentage of crop marketable.	Yield per Acre (Bushels)		
				Marketable	Total	Total less Seed used.
One-sixteenth oz. ..	1	1.3	61.0	36.8	47.5	46.2
One-eighth oz.	1	2.6	88.6	78.8	89.7	87.1
One-quarter oz.	1	5.2	89.7	98.4	111.1	105.9
One-half oz.	1	10.3	88.7	109.4	129.0	118.7
One oz.	1	20.6	89.5	129.9	148.4	127.8
Two ozs.	1	41.2	87.6	149.7	173.9	132.7

The results show that the size of set planted has a very marked influence on the yield produced. Under exactly the same conditions there was a variation of from 47.5 to 173.9 bushels of potatoes per acre per annum due to the difference in size of the potato sets planted. It will be noticed that in the yield of marketable potatoes the differences were almost as great as in total yield per acre.

PLANTING POTATO SETS OF EQUAL SIZE WITH A VARYING NUMBER OF EYES IN EACH SET.

There is much difference of opinion as to how many eyes each potato set should contain. As the size of the potato set itself has a marked influence on the yield of potatoes it is important to use sets of uniform size if definite results from using a different number of eyes are to be obtained. An experiment was conducted in the experimental plots in which every set was cut to weigh one ounce and in which the number of eyes in the different sets varied from one to five. The experiment was conducted in duplicate each year by using two varieties of potatoes and was continued for five years in succession. The conditions of planting were the same as those given in the preceding experiment. The table below gives the average results for five years' experiments in planting one ounce potato sets containing from one to five eyes each:—

Number of Eyes in ounce sets	Average Results for five years		
	Weight of 30 Largest Potatoes per Plot (pounds)	Percentage of Crop Marketable	Yield of Potatoes per Acre per annum (bushels)
Each Set containing 1 oz. and 1 eye	9.8	86.2	139.8
" " " 1 " " 2 eyes	9.2	84.6	151.3
" " " 1 " " 3 "	9.0	82.6	153.9
" " " 1 " " 4 "	8.6	81.2	161.3
" " " 1 " " 5 "	8.5	83.3	165.1

The potato sets of one ounce in weight, which contained one eye each, produced the largest potatoes and the highest percentage of marketable tubers but the lowest yield per acre. With one slight exception as the number of eyes increased from one to five in the potato sets there was a decrease in the size of the largest potatoes, a decrease in the percentage of crop marketable and an increase in the average total yield of potatoes per acre per annum. The results of this experiment show that the number of eyes in potato sets have a distinct bearing on the yield per acre.

Many potato growers are of the opinion that potato sets should be planted with the cut surface downward and the eyes facing upward. In an experiment conducted at the College every set in one plot was placed with the eyes downward and every set in the other plot with the eyes upward. This experiment was conducted in duplicate and the average yields per acre for the two methods were practically identical. It would seem that there is little to be gained from having the eyes in the potato sets pointed in any special direction.

PLANTING SINGLE EYES FROM DIFFERENT PARTS OF THE SEED TUBER.

In each of five years an experiment was conducted by planting single eyes from different parts of the tubers. As will be seen from preceding experiments the yield of potatoes varies with size of sets planted, great care was therefore taken to have sets planted of exactly the same weight. The experiment, therefore, tests the comparative value of the eyes from different parts of the tuber and is not influenced by the difference in the size of the sets planted. This experiment was conducted with two varieties of potatoes each year. The results are the average of ten separate tests. The cultural methods were similar to those in the two preceding experiments. The following table gives the average results for five years in testing single eyed sets taken from different parts of the tubers:—

Potato Sets of uniform weight, and containing single Eyes taken from different parts of the tubers.	Average Results for five years		
	Weight of 30 Largest Potatoes per Plot (pounds)	Percentage of Crop marketable (4 years)	Yield of Potatoes per Acre per annum (bushels)
Middle portion	12.4	85.3	174.8
Stem end	11.5	82.1	167.7
Seed end	11.9	84.2	162.0

In four out of five years the eyes taken from the central or middle portion of the potatoes produced the highest yields per acre. In the other year the eyes taken from the seed ends of the potatoes were most productive. The sets from the middle portion of the potatoes produced the highest marketable yield per acre, there being a difference of 1.3 bushels per acre over sets taken from the seed end of the potato.

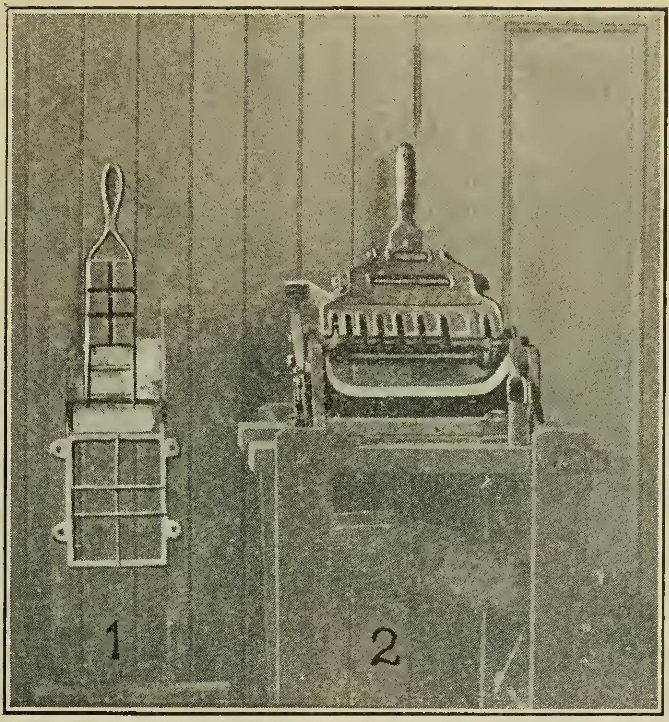
PLANTING POTATO SETS AT DIFFERENT TIMES AFTER CUTTING.

Some potato growers are of the opinion that it is best to cut seed potatoes from three to five days before they are planted. An experiment was conducted at the College for a period of eight years with the object of securing information on this point. Two varieties were used in the experiment each year. Two lots of potatoes each containing the same number and the same weight of tubers were used, one lot of each variety of potatoes was cut from four to five days before planting time and the other lot of each variety was cut and planted on the same day. The cultural methods were uniform throughout and were the same as reported in previous experiments. The table below gives the average of sixteen separate tests conducted for a period of eight years from planting potatoes at different times after cutting:—

Time of Cutting and of Planting Seed Potatoes	Percentage of crop Marketable Average 8 years	Yield of Potatoes per Acre (Bushels) Average 8 years
Potatoes cut and planted on the same day	77.4	170.1
Potatoes cut four or five days before planting	76.3	162.3

In the average results of the experiment conducted for eight years potatoes which were cut and planted on the same day gave an annual yield of 7.8 bushels per acre per annum more than those which were cut from four to five days before they were planted. Not only was the yield per acre greater but the percentage of marketable potatoes produced from the seed tubers which were cut and planted immediately was also higher.

In a co-operative experiment conducted throughout Ontario for a number of years potatoes which were cut and planted immediately gave an increased yield of 16.6 bushels over potatoes which were cut four, five and six days before planting. This co-operative experiment was the average of over three hundred tests conducted on as many farms in Ontario.



Machines for Cutting Potatoes for Planting.
(1) Small machine; (2) Large machine.

INFLUENCE OF PLASTER AND LIME SPRINKLED ON FRESHLY CUT SEED POTATOES.

In order to obtain information which would be a guide in the treatment of freshly cut seed tubers an experiment was conducted for five years in succession in which freshly cut seed potatoes were sprinkled with plaster or with lime or were left untreated before planting. In order to secure the most accurate data on this subject from four to six separate tests were made each year. In the five year period a total of twenty-two tests in all were made. Finely ground land plaster and slaked lime were used. The planting took place in the latter part of May or the first week of June each year and equal amounts of seed were used in the different plots. The cultural methods were the same as those mentioned in previous experiments. The table below gives the average of the twenty-two tests conducted for five years in treating freshly cut seed in different ways before planting:—

Treatment of Freshly Cut Seed Potatoes	Weight of 30 Largest Potatoes per Plot (pounds) Ave. 5 years	Percentage of Crop Marketable Average 4 years	Yield per Acre (bushels) Average 5 years
Coated with Ground Plaster	13.9	81.1	214.4
Coated with Slaked Lime	13.6	78.9	200.6
Not Treated	12.8	78.8	190.8

The results show that freshly cut seed potatoes which were coated with land plaster gave 23.6 bushels per acre per annum over potatoes left untreated. The seed treated with lime occupied an intermediate position between those treated with land plaster and those left untreated. In four out of the five separate years potatoes treated with land plaster produced the highest total yield per acre and also the highest percentage of marketable potatoes.

In an experiment which was conducted for seven years in succession and in duplicate in which finely ground brick and road dust were used for coating freshly cut seed potatoes in comparison with land plaster, results were as follows:—Untreated, 179.4; Road Dust, 186.0; Ground Brick, 189.5; and Land Plaster, 191.1 bushels per acre.

In a co-operative experiment conducted for a period of five years in which ninety-seven farmers tested freshly cut potato sets coated with land plaster and freshly cut sets untreated the yields were as follows:—Freshly cut sets coated with Land Plaster, 187.7; Untreated Seed, 177.6 bushels per acre.

DEPTH OF PLANTING.

The depth at which potatoes are planted will depend upon the type of soil, the method of cultivation, climatic conditions likely to prevail during the growth of the plant, and whether the potatoes are grown for early market or as a late or main crop. It is usual to plant early potatoes rather shallow. On heavy cold soils potatoes should not be planted to a greater depth than from three to four inches while on light loam soils which may be lacking in moisture they are often planted to a depth of five inches. The soil in the experimental plots at the College is an average clay loam. On this type of soil potatoes were planted at depths of 1, 3, 5 and 7 inches in each of seven years. From two to four varieties were used in the experiment each year. Potatoes were planted in the latter half of May or the first week of June depending on the season. Level cultivation was used throughout. The following table gives the average results of tests conducted for seven years in planting potatoes at four different depths:—

Depth of Planting	Depth of new Potatoes below surface (inches) Average 3 years	Yield per Acre (Bushels)	
		Marketable Potatoes Average 5 years	Total Crop Average 7 years
One inch	1.7	177.4	192.4
Three inches	3.0	188.9	202.8
Five inches	4.0	188.6	206.2
Seven inches	4.9	164.1	189.6

It will be seen that the greatest average total yield per acre was obtained by planting potatoes at a depth of five inches. The results, however, varied in different years, the largest yield per acre in one year being obtained where potatoes were planted to a depth of seven inches and another year where the planting depth was one inch. Deep planting gave the highest returns in dry seasons and shallow planting when there were frequent rains. When total yield, yield of marketable and percentage of potatoes sunburned as well as general quality of potatoes were taken into consideration there was little difference from planting potatoes at depths of three to five inches on this type of soil.

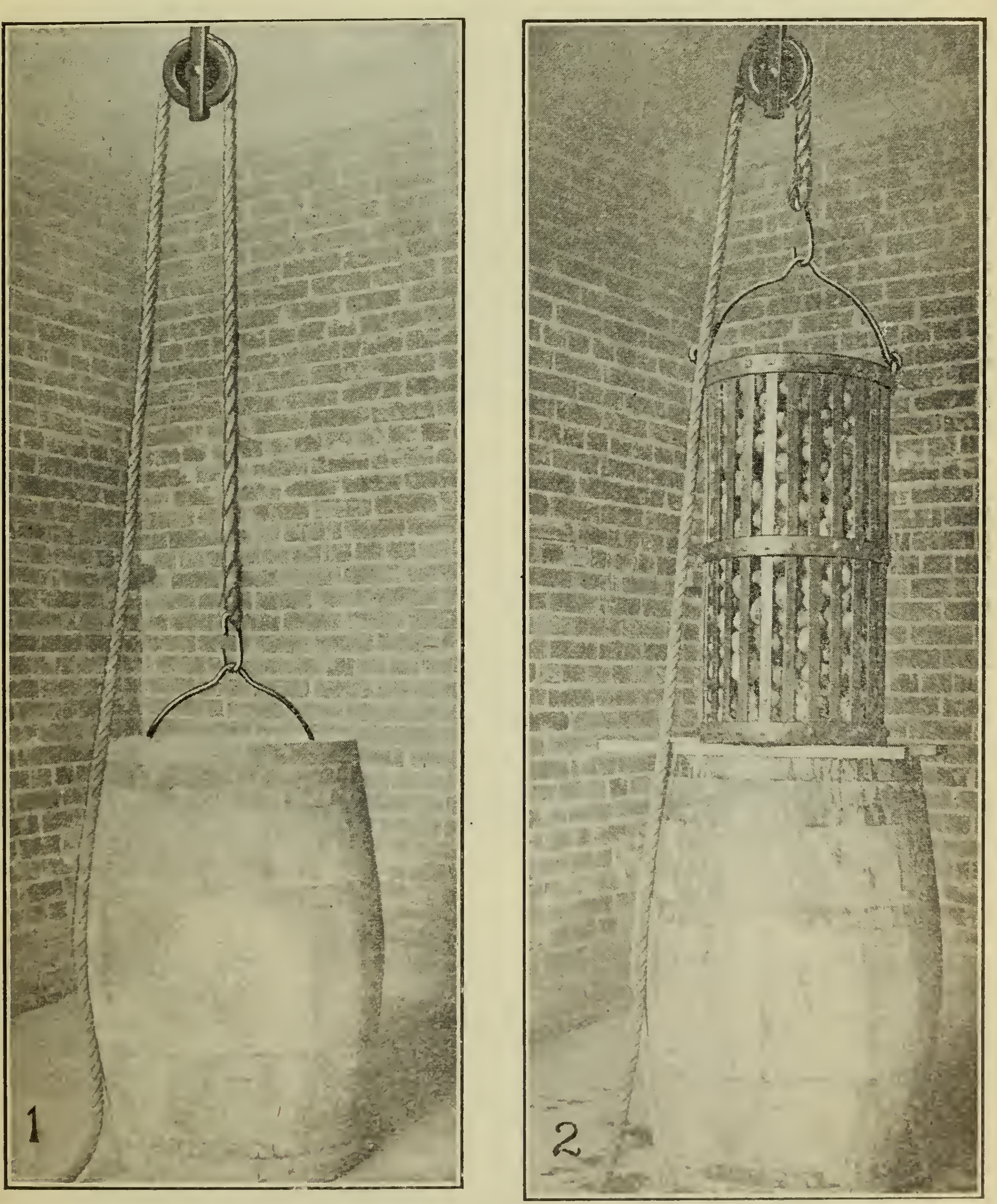
DISTANCE APART OF ROWS AND POTATOES IN ROWS.

The distance apart of rows and potatoes in the row will depend on the variety grown, the available plant food in the soil, rainfall and soil drainage and the size of potato sets planted. The results of experiments at Guelph and the experience of many successful potato growers indicate that for the most economic production potato rows or drills should be spaced about thirty to thirty-three inches apart and the potato sets dropped at distances of ten to fourteen inches. The Rural New Yorker type of potato produces its tubers directly under the stalks and in a close bunch and it is not necessary to plant the sets of this variety as far apart as those of the Green

Mountain whose tubers in growing spread quite widely in the soil. For early market potatoes are often planted at a distance of nine inches in the rows as the crop is usually dug before it is matured.

Rate of Planting.

The amount of seed required to plant an acre depends chiefly on the method of planting and size of set. In the principal potato growing districts of Ontario growers use from fifteen to twenty-five bushels of seed tubers to plant an acre.



Method of Treating Potatoes for Scab by Immersion in Formalin Solution. (1) Potatoes being immersed for two hours; (2) Potatoes draining after immersion.

Treatment for Potato Scab.

This disease manifests itself in the form of rough, corky, brown spots on the surface of the potatoes. Botanical investigators have shown that the organism of common scab may be conveyed to the soil with farmyard manure as well as carried on the potato seed tubers and that the organism will live in the land for several years and still have the power of causing the disease. The organism thrives best in soils which are slightly alkali. The amount of scab seems to increase with the quantity of vegetable matter in the soil especially where there are fresh applications of barnyard manure.

The two substances commonly used for the prevention of scab are corrosive sublimate and formalin and both of these are effective in reducing the amount of scab if used in the right proportions.

An experiment was conducted at the Ontario Agricultural College for a period of ten years in treating potatoes for scab. Potatoes in one plot were left untreated and those in another plot were treated with corrosive sublimate (mercuric bichloride) a substance very poisonous to animals and human beings. The corrosive sublimate treatment consisted of dissolving two and one-quarter ounces of this material in two gallons of hot water and after an interval of ten to twelve hours diluting with thirteen gallons of water. The whole potatoes were immersed in this solution for one and one-half hours, then spread out to dry and cut and planted in the usual manner in comparison with others which had been left untreated.

Another experiment was conducted for five years in treating potatoes for scab by the formalin method. This consisted of soaking seed potatoes for two hours in a solution of formalin (40% formaldehyde) made by mixing one pint of the formalin with thirty gallons of water. Both this experiment and the one with corrosive sublimate were conducted in duplicate, two varieties of potatoes being used in each of the separate tests.

No increased yield of potatoes per acre was obtained from using either of these seed disinfectants but the amount of scab in most years was very considerably reduced.

In order to grow the best quality of potatoes as free from scab as possible, the crop should be grown in a definite rotation. Where possible the use of fresh barnyard manure should be avoided and only manure which is free from the scab organism used. The use of fertilizers having an alkaline action such as wood ashes and lime should also be avoided.

The grower should treat seed even though the potatoes seem to be comparatively free of scab. Both the treatments mentioned are comparatively simple and inexpensive. After potatoes have been treated care should be taken that they are not again contaminated with the organism from contact with dirty bags, boxes, baskets, etc. As previously mentioned corrosive sublimate is a deadly poison and all treated potatoes should be planted, or if not used in this way, destroyed. The use of corrosive sublimate also reduces the amount of rhizoctonia and black leg.

LEVEL VS RIDGED CULTURE.

Two systems are commonly used in the growing of potatoes in Ontario, level and ridged. The results of experiments conducted for several years at the College and co-operative experiments by farmers over Ontario showed little practical difference in the use of these two methods. In cool rather wet seasons results were in favor of hill culture while in hot dry summers results favored level culture.

CULTIVATION AFTER PLANTING.

Potatoes after planting should receive thorough cultivation. Only in this way will the soil moisture be conserved, plant food liberated, potato ground kept in a loose friable condition and weeds destroyed.

After potatoes have been planted and before they are above ground many weeds which have germinated will be destroyed by using a weeder or a light harrow. This treatment may be continued until plants have reached a height of two to three inches. Soon after the rows can be distinguished the cultivator may be used for the first time. The cultivator should be used throughout the season as often as is necessary to destroy weeds and keep the soil in a loose friable condition. Cultivation is usually continued until the potato tops have almost closed in the rows. Slightly moulding the rows at the last cultivation will tend to cover any potatoes which might be above the surface of the ground and prevent greening.

Spraying Potatoes in different years in the Experimental grounds at the Ontario Agricultural College.

SPRAYING POTATOES.

The object in spraying is to protect the foliage from injury caused by the attacks of fungus diseases and insects.

In the two following paragraphs will be found the joint recommendations of J. E. Howitt, Professor of Botany, and L. Caesar, Professor of Entomology, of the Ontario Agricultural College, for spraying for late blight and rot and to control potato beetles.

Commence spraying when the potato beetle eggs are just hatching which will usually be when the potato plants are from five to eight inches high, and keep the foliage covered throughout the season with the Bordeaux, taking special precautions to see that it is well covered during wet weather. Never put off spraying because it looks like rain, for once dry the spray mixture will withstand rain and be on at the critical time.

For the first application use Bordeaux—four pounds copper sulphate, six to eight pounds hydrated lime, and forty gallons of water, with two pounds of arsenate of lime to each forty gallons. Repeat the spraying often enough to keep the foliage well covered. Add the arsenate of lime to the Bordeaux only when required for beetles. No stated number of sprayings of the Bordeaux can be recommended. The number depends on the weather. The wetter the weather the larger the number. If the season is favorable for blight and rot, continue spraying until the plants have finished their growth and died. It is important to use plenty of Bordeaux at each application. Forty gallons may be sufficient to cover an acre when the plants are small, but when the plants are large from eighty to one hundred gallons or more will be required for each acre. It is often found necessary to spray each row twice at each application when the plants are large. It should be borne in mind that spraying only pays when it is thoroughly done.

An insecticide that has proven quite effective in killing potato bugs is one made up of 8 ounces of Paris Green, 1½ pounds of Arsenate of Lead and 40 gallons of water. This treatment, however, is more expensive than using the arsenate of lime treatment. A large number of tests made by the Department of Field Husbandry and by other Departments at the College show that the use of Bordeaux mixture prolongs the life of the potato plants, increases the yield per acre, the percentage of marketable potatoes and lessens the amount of damage from rot.

THE IMPORTANCE OF ROGUING POTATO FIELDS.

A thorough roguing of the crop will enable the grower to remove and destroy those plants which show signs of such diseases as Rhizoctonia, Black Leg, Fusarium Wilt, Spindling-sprout, Mosaic, Curly Dwarf and Leaf Roll and thus lessen the injury to the growing crop as well as to the future seed crop. The grower at the same time is able to remove the plants of other potato varieties from his field and purify his variety.

DIGGING.

Potatoes grown for early market are usually dug when the vines are still green, the potatoes at this time being about two-thirds matured. At this stage of maturity the skin of the potato is easily broken and great care is necessary in handling. For this reason early potatoes, especially on small areas, are usually harvested with the potato fork. Late maturing or main crop potatoes are usually harvested ten days to two weeks after the tops are dead. Potatoes possess the best table quality when they are well matured. When potatoes are grown in long rows and on considerable areas they are harvested with the ordinary plough, or the double mould-board plough when special forked attachments are used to free the tubers of dirt and spread them on the surface of the ground. In many of the specialized potato growing districts of Ontario potato diggers are now commonly used. The Elevator potato digger which is operated by two or four horses and has a harvesting capacity of three or four acres or five hundred to twelve hundred bushels per day is a type now in common use.

SORTING AND GRADING.

The sorting of potatoes for early market usually takes place in the field, tubers of the right size and shape for market or home use being picked immediately after digging. Both early and late maturing potatoes should not be allowed to lie long in the hot sun and if possible should be harvested in dry weather. When the late or main crop consists of several acres it is a good plan to run the potatoes through a potato grader. This machine sorts according to size and may be operated in the field at the time of harvesting or at some convenient place before the potatoes are stored for the winter. During the operation of the potato grader the unsound, misshapen and diseased tubers may be removed by hand. There are several makes of potato graders on the market which do efficient work. The proper grading of potatoes is necessary in putting a uniform product on the market.

STORING.

Bearing in mind that a potato is at all times active physiologically, i. e., a living organism, conditions must be provided which will prevent severe losses in storage. Above all, it should be borne in mind that the tender skin of a freshly harvested tuber is easily scratched or broken, that diggers or implements may cause cuts or bruises, which prove disastrous when such potatoes are placed into unsuitable storage. Moist tubers, especially when cut and bruised, are the first to succumb. Therefore, avoid all bruises, cuts, etc., and, if at all possible, the placing of potatoes into any kind of storage until perfectly dry. The proper temperature at which potatoes should be stored is 35 to 37°F. It is absolutely essential that potatoes while in storage should be kept as dry as possible, and the best method to obtain this result would be to store them in crates, providing means for the free circulation of air among the crates throughout the entire storage period. Bin storage requires less space and is less expensive, but one objectionable feature is that it is very difficult to prevent the tubers from sweating. If, however, bin storage is resorted to, care should be taken to avoid piling the tubers against the wall or directly on the floor, a practice which does not permit of sufficient ventilation, especially where a large quantity is piled. A suitable means of ventilation can be provided by constructing a false wall of slats nailed sufficiently close together to retain the potatoes and about 6 inches distant from the main wall. In addition a temporary floor should be laid down about 6 inches above the other floor, having sufficient space between the boards to ensure free circulation of air under and around the pile. In the case of large piles, ventilators made of wooden slats should be provided at regular intervals, in addition, both vertical and horizontal throughout the pile.

MARKETING.

The potato grower is dependent on the wishes of his customers for his market. In order to obtain this market and retain it he should provide a first-class product and sell it in the most attractive form. In order to obtain the highest prices, potatoes should be uniform in appearance, sound, smooth and of good table quality whether they are sold in the basket, the bushel, the bag, the barrel or by the carload. The farmer who specializes and grows potatoes on a large scale should obtain all the available information on markets, statistical information on the production of potatoes in his own and other Provinces and keep in close touch with potato growing and selling organizations.

The Province of Ontario can grow as large yields per acre and potatoes of as good quality as can be produced anywhere in Canada. There is a good market for large quantities of potatoes, uniform in size and shape and possessing good quality.

GROWING CERTIFIED SEED POTATOES.

During the past few years it has been amply demonstrated that Certified seed potatoes can be depended upon to give higher yields of better quality potatoes than potatoes which will not meet certification requirements.

Few field crops are attacked by as many diseases as the potato. Some diseases are recognizable only on or in the tuber; others can be distinguished only in the field while the plants are growing. Disease-free seed potatoes cannot be recognized merely by an examination of the tubers, for apparent soundness is no guarantee of freedom from disease, and notwithstanding good appearance, they may carry diseases which may prove very destructive. For instance, there are few diseases which more adversely affect the yield than "Leaf Roll" and "Mosaic"; yet neither of these diseases is recognizable in the seed tuber.

The elimination of disease is the first principle in obtaining good seed potatoes. Careful inspection of the individual growing plants at various stages of their growth is essential to detect diseases and lack of vigour; just as essential as is field inspection generally in order to detect poor stands, mixtures, etc.

MEANING OF CERTIFICATION.

Certification is a means of recording seed stock that is of good type, from vigorous plants, and relatively free from serious diseases. When potatoes have been inspected in the field and after harvest by an officer of the Dominion Department of Agriculture, and have been found to be vigorous and to conform to certain standards of freedom from serious diseases and of purity of variety, they may be certified. Official tags are issued for such seed stocks, and all potatoes sold as Certified seed must have the official tag attached to each container of potatoes.

It is an indictable offense under the Destructive Insect and Pest Act to use any other kind of tag likely to mislead an unsuspecting public. Growers and associations are permitted, however, to attach their own tags or brand, or mark any container with any special description, but such must only be done when the official tag is present on the container.

STEPS NECESSARY TO OBTAIN CERTIFICATION.

Early in spring an application form should be obtained from the Dominion Botanist, Central Experimental Farm, Ottawa, or from the nearest district inspector. This form should be filled in and returned in a stamped envelope to the nearest district inspector. All applications must be made on or before June 15, on which date the lists are closed. No inspection can be guaranteed after this date. Application forms received after June 15 will be returned to the sender with a note advising him that the lists are closed and his application is cancelled, unless exceptional conditions warrant an extension.

REGULATIONS GOVERNING CERTIFICATION.

1. The seed used in planting the crop for which certification is desired must have been taken from stock which passed both field and tuber inspections the previous year. Seed should be of desirable type for the variety entered, and should be as free as possible from scab and Rhizoctonia, or be treated before planting.

Any variety, however, which is correctly named may be certified after passing all inspections for two years in succession.

2. Potatoes intended for inspection and certification should be planted at least 200 feet from other potatoes. This is to avoid possible infection. Disregard of this ruling has led to the rejection of many fields.

3. No fields which upon first field inspection have more diseases than are permitted in the standard, or show insufficient growth and vigour, will be given a second inspection or further consideration for certification.

4. Fields should be kept well cultivated and sprayed for blight and insects. Weedy, poorly cultivated fields, and those showing many plants stripped by insects, will be disqualified.

5. Seed potatoes must be dug and handled with the greatest care to prevent

unnecessary bruising or they will go down in storage. They must be kept from danger of frost injury. Tubers exposed to frost injury will not be certified.

6. First field inspection will commence about six or seven weeks after the average planting date for the district. Second inspection will follow in from two to four weeks.

After field inspections are completed, growers will be notified by card if their fields have passed. The return of the card to the district inspector will ensure their receiving tuber inspection. In the case of a field failing to pass the field inspection the grower is notified of this fact by letter and the crop is not considered further for certification. Tuber inspection will be given at digging time, or as soon after digging as possible, and continue until all who apply for tuber inspection have been visited.

CERTIFIED SEED POTATOES—INSPECTION STANDARDS.

FIELD

	1st Inspection %	2nd Inspection %
Blackleg	3	1
Leaf Roll, Curly Dwarf	2	1
Mosaic	2	1
Wilts	3	2
Foreign	1	½
Misses (if due to roguing)	2	—

Providing that in no case shall a total of more than 6 per cent. disease be allowed on first inspection or more than 3 per cent. on second inspection.

TUBER

Tags to be issued by inspector only on the express understanding that tubers must conform to the following standard when shipped:

	%
Wet rot (Bacterial)	½
Late blight and dry rot	1
Scabs or rhizoctonia—	
Slight	10
Severe	5
Necrosis, wilts, and internal discolorations, other than due to variety	5

Providing that in no case shall a total of more than 7 per cent. be allowed except in the case of slight scab or Rhizoctonia.

Not more than 1 per cent. of powdery scab allowed under scabs.

Not more than 2 per cent. of the tubers to be malformed, or spindly, or badly damaged by sunburn, cuts, cracks, bruises, insects, etc.

No frost injury or foreign tubers shall be allowed.

Not more than 5 per cent. by weight of the tubers shall be below 3 ounces or above 12 ounces.

At fall bin-inspection, if more than 3 per cent. late blight be found in bin, grower will not be allowed to grade for fall shipment but may hold for spring shipment, subject to re-inspection.

7. Growers should allow at least ten days in storage before attempting to grade.

8. Potatoes must not be sold as Certified Extra No. 1 seed potatoes unless they

have the official certification tags attached to the containers. Certification is not complete until that time.

9. Seed stocks improperly stored as indicated by excessive sprouting or shrivelling will be refused certification.

10. Any person found guilty of misusing certification tags will be liable upon conviction to the penalty or penalties imposed or set under The Destructive Insects and Pest Act.

RULES AND REGULATIONS REGARDING THE SALE OF COMMERCIAL POTATOES AS ADMINISTERED BY THE FRUIT BRANCH.

(a) Canada A quality, which shall include only sound, reasonably mature potatoes of similar varietal characteristics which are practically free from dirt or other foreign matter, frost injury, sunburn, abnormal growth, growth cracks, cuts, scab, blight,, soft rot, dry rot or damage caused by disease, insects or mechanical or other means. In this grade the diameter of potatoes of the round varieties shall not be less than one and seven-eighths inches, and of potatoes of the long varieties one and three-fourths inches.

(b) Canada B quality, which shall include only reasonably mature potatoes of similar varietal characteristics which are practically free from dirt or other foreign matter, frost injury and soft rot and which are free from serious damage caused by sunburn, cuts, scab, blight, dry rot or other disease, insects or mechanical or other means. The diameter of potatoes of this grade shall be not less than one and one-half inches.

In order to allow for variations incident to commercial grading and handling in each of the above two grades five per cent. by weight of any lot may be under prescribed size, and in addition six per cent. by weight of any such lot may be below the remaining requirements of this grade; but not more than one-third of such six per cent., that is to say not more than two per cent. by weight of the entire lot, may have the flesh injured by soft rot.

(c) Canada C ungraded quality shall include only potatoes of one and one-half inches or more in diameter.

Definitions of Terms for Grading.

(a) "Practically free" means that the appearance shall not be injured to an extent readily apparent upon casual examination of lot, and that any damage from the causes mentioned can be removed by the ordinary process of paring, without appreciable increase in waste over that which would occur if the potatoes were perfect. Loss of the skin only shall not be considered as an injury to the appearance.

(b) "Diameter" means the greatest dimension at right angles to the longitudinal axis.

(c) "Free from serious damage" means that any damage from the causes mentioned can be removed by the ordinary processes of paring without increase in waste of more than ten per cent by weight over that which would occur if the potatoes were perfect.

(d) "Soft rot" means a soft mushy condition of the tissue, from whatever cause.

(e) "Abnormal growth" means excessive or second growth to the detriment of quality.

A Potato Field

The result of thorough seed-bed preparation and using good seed.

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BULLETIN No. 340] [OCTOBER, 1928

Ontario Department of Agriculture

PARASITES INJURIOUS TO SWINE

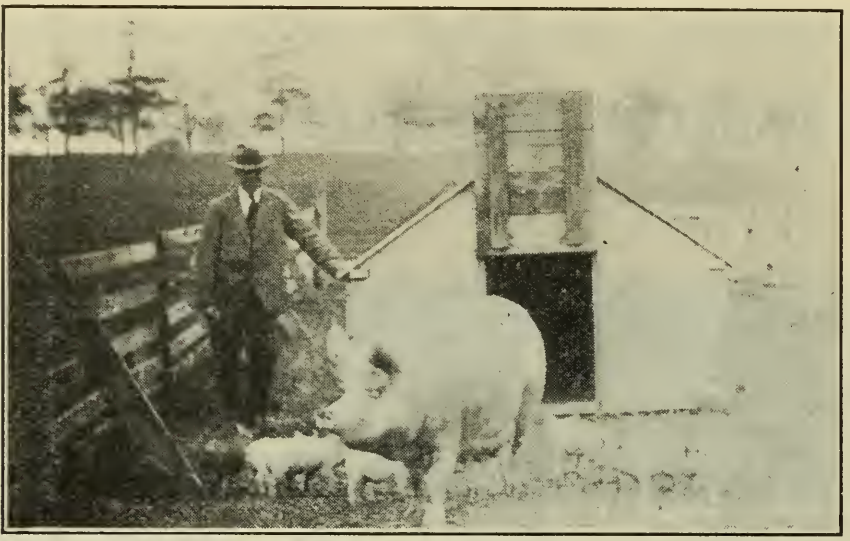
LIONEL STEVENSON, Provincial Zoologist

ROUND WORMS
Twenty-four Round Worms taken from the intestine of a three-months-old pig.

This very common parasite causes the loss of many thousands of dollars each year. Probably ten per cent of all pigs born die, due to its presence, and a handicap is placed on all pigs during the first four months of life. As a pig grows older the injury lessens. Protect the young from the ravages of this worm.

THE SWINE PARASITE HANDICAP.

Much of the unthrift seen in young pigs is due to parasitism. The young in particular suffer from the various parasitic invasions, old animals generally develop an immunity against intestinal parasites and show little or no evil from the presence of a few worms. The older or breeding animals of the herd will, if not treated with an efficient vermifuge and handled under highly sanitary conditions, harbour enough worms to keep the premises seeded down with worm eggs, a very undesirable condition when we consider the safety of the young pigs born on such premises. The little pig born of a parasite infested mother, living in a pen or yard where worm eggs make up a good percentage of the dust or filth on the pen floor, has not a chance in the world of escaping infestation. The first time the young pig seeks nourishment while nosing around the teats of his mother, he will get a mouthful of worm eggs, in this way starting the parasitic handicap the day he is born.



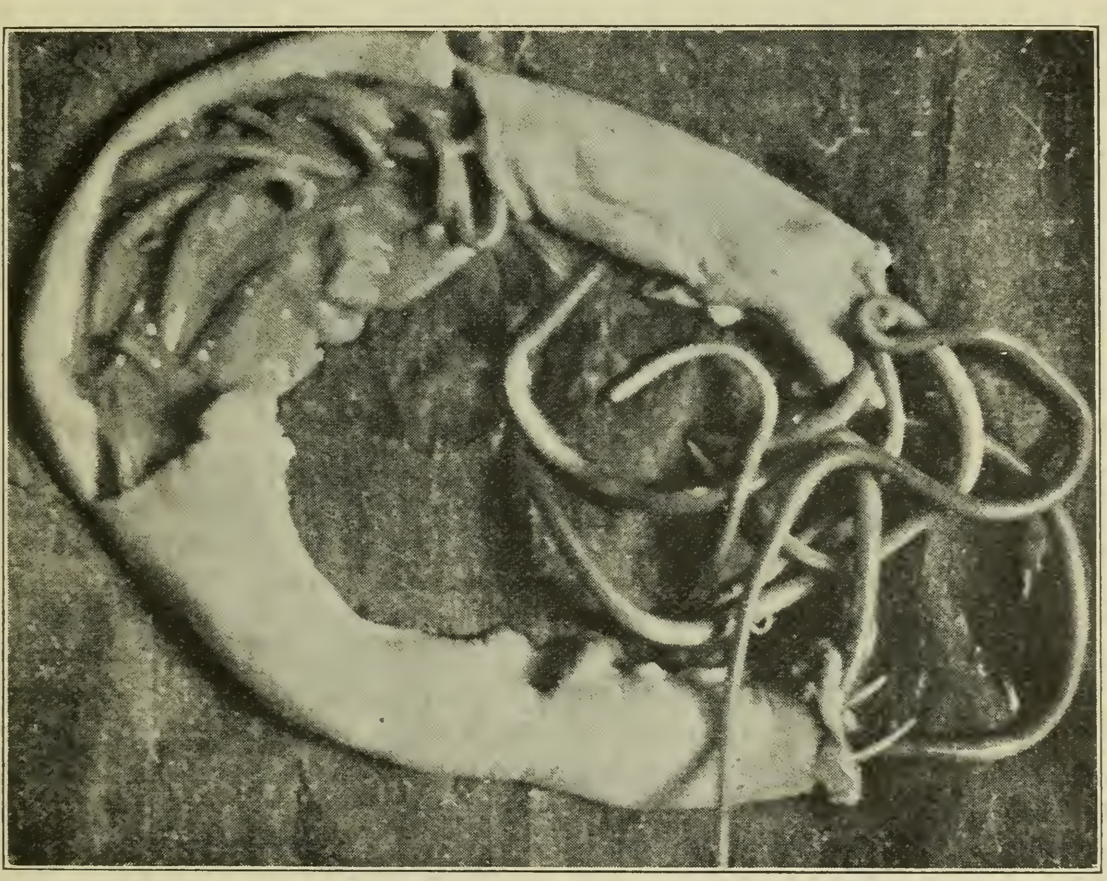
A colony house located on clean, fresh ground makes an ideal home for the young pigs. It is during the period of babyhood that the damage is greatest from worm infestation. Give the young pigs a colony house located in a corner of the clover field in which to start life.

THE WORMY PIG AS A COMMERCIAL PROSPECT.

With high-priced feed, building equipment and labour to be balanced against the sale price of the product, the part that we call labour income, or profit in our pig feeding activities, may be adversely affected by the presence of parasites. Too frequently the parasites take all of what might have been profit and the labour has been in vain. The profitable pig is the disease free pig that reaches the approved bacon weight when it is six months old. The pig that takes eight to twelve months to reach bacon weight is not profitable frequently for the reason that it has carried the worm handicap, under which it was a waster of grain and labour. A pig infested with internal parasites can not be profitable, as it is robbed of food, irritated and poisoned.

The Round Worm of Swine (*Ascaris lumbricoides*).

Description—The colour varies from a greyish yellow to a light pink in adults. The young ascarids are white or cream coloured. In size, the adult females vary from eight to fifteen inches in length, while the males are smaller and do not often exceed nine inches in length. Ascarids of all sizes ranging from a fraction of an inch up to eighteen inches in length may be found in the same pig's intestine. Large specimens have a mid-body diameter of one-third of an inch or less and taper toward the extremities. The tail end or posterior extremity is bluntly pointed, while the head end of the ascarid terminates in a mouth, consisting of three lips, the margins of which are dentate. The dorsal lip is furnished with two sensory papillae each with a double termination. The two ventral lips each carry one large double papilla and two small ones. The males are easily distinguished from the females in that the posterior end is bent, and the body of smaller diameter than it is in females of equal length. The females have a straight posterior end, as shown in the illustration representing the Round Worm of Swine. The vulva of the female is located in a band-like depression at a point, when measured from the head, at about one-third the body length toward the posterior end. The egg of the female ascarid is ovoid in form, a small percentage will show some variation from the ovoid form and may appear to be elongated or to be nearly round in outline. Eggs are produced in great numbers, one female ascarid may during a full life time release 25,000,000 or more eggs. The eggs are well protected by an albuminous coat and can stand much adverse weather to which they may be subjected to after passing from the body of the pig with the feces.



A section of pig intestine as often seen filled with Round Worms. Imagine your own intestine filled this way. Could you be happy and content? No, you would be cranky and irritable, ravenously hungry at times, and hate the sight of food at other times. You would be restless day and night and wear your teeth out with incessant grinding. A human being can go to a drug store and get relief, but the pigs can't. They are your slaves and it is your duty to protect them from the ravages of this worm.

Life History—The eggs of the ascarid must pass from the body of the pig in order to reach conditions of temperature, moisture and oxygen supply suitable for the hatching process. The normal temperature within the intestine of the pig is such that it retards the development of the worm egg, so a very large percentage pass out with the pig feces in the same stage of development acquired at the time the egg left the uterus of the female worm. After passing from the body with the pig feces, the eggs will, if conditions are very favourable, develop to the vermiform stage in from ten to fourteen days. Should the temperature and moisture conditions not be favourable the eggs may be destroyed or their development be retarded. It is generally retardation, as the eggs are hard to destroy. The ascarid egg is very resistant to weather conditions and is not injured by the severe winter weather in Ontario, if given the protection of ordinary pig yard filth. The moisture factor required for the incubation of the ascarid egg is never wanting on the floor of the average pig pen, so this factor is generally favourable in the winter and frequently so in the summer in many indoor shelters or pens. The temperatures of piggeries vary greatly during the year, ranging from 40 degrees to 80 degrees F., the higher temperature being favourable to the incubation of the eggs, while the lower temperature is not favourable. In temperatures below 70 degrees F., development is slow and it may take weeks for the eggs to become vermiform. Fertilized eggs may remain on the pen floors, in wallow holes, manure piles, or surface soil of yards for a year or more, to become vermiform when exposed to conditions of light, heat and moisture suitable for the incubation process. The embryonated or vermiform egg is taken by the little pig while nosing around the breast of the sow, or while taking feed from the pen floor or feed trough. Should the pen be inhabited by a wormy brood sow (we find that 50 per cent. of the brood sows carry worms), the floor of the pen will be heavily seeded with worm eggs, so there is, under such conditions, no escape for the young pigs. They will be wormy, too. After the vermiform egg reaches the small intestine of the young pig along with the food swallowed, the shell of the egg is dissolved off and the young worm released. Once free in the intestine, it penetrates the wall to reach a blood vessel. It is very small and very active at this time, being but from .2 to .3 millimeters long (that is, 125 of these larval worms placed head and tail would measure approximately one inch). Once in a blood vessel the little worm is carried to the liver, then to the heart and from there to the lungs of the host pig. The conditions existing in the lung, suit the larval development of the worm and it remains there for a period of six or eight days, growing in that time to be about 2.4 millimeters in length. This developmental stage being completed the little worm leaves the lung tissue and passes by way of the bronchi and trachea to the throat to be coughed out or swallowed. If swallowed, it returns to the intestine of the pig, where it may lodge and grow to sexual maturity in eight to ten weeks' time. If coughed out into a feed trough it may be taken up by another pig. Many of the young worms apparently do not find conditions just right in the intestine of some pig and fail to gain lodgement; however, enough worms find congenial conditions to cause them to grow to maturity and keep the plague going. This peculiar round or cycle, vermiform egg to the stomach, the larva from the stomach to the intestine, then into the blood stream to the liver, heart and lungs, and then back to the intestine may cause considerable damage to the lymph glands, liver and lung tissue of young pigs. Any degree of injury may follow the migration of the ascarid larvae, depending upon the numbers migrating and the susceptibility of the pig. Heavy infestations complicated by the presence of pathogenic bacteria bring on the condition known as ascaris pneumonia, often fatal to the young pig. With moderate infestations no marked symptoms are present, the young pig gradually descends into the class of the unthrifty and fails to develop at a satisfactory rate.

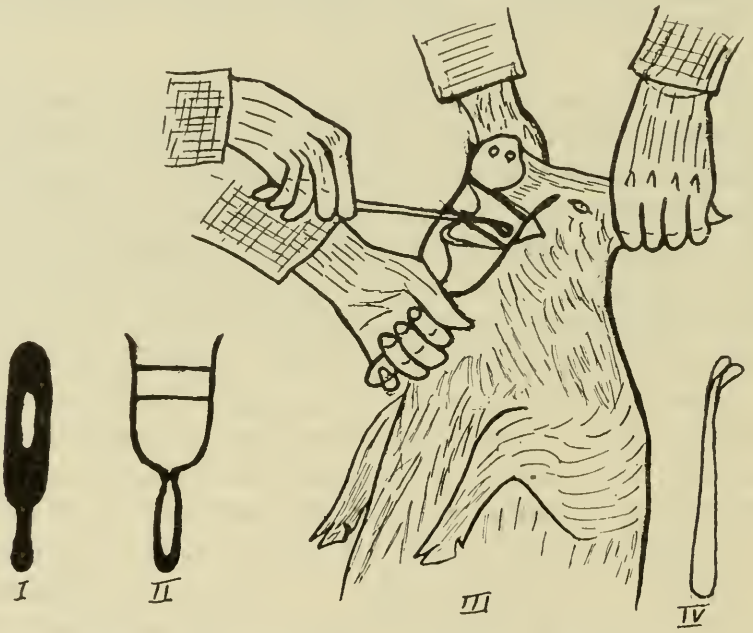
Symptoms of Infestation—During the initial stage, with a heavy migration of larvae in progress, the temperature may go up to 105 degrees F., or even higher—the respirations become more frequent and may be irregular in character—a husky cough is generally present. As the pig grows older, if the intestation is heavy it becomes unthrifty, pot bellied, poor doer, with a variable appetite. Some days pigs do not feed well, other days they can not get enough. Diarrhoea alternates with constipation in cases where the infestation is heavy. When the infestation is light, no symptoms indicating the presence of worms may be noted. A post mortem examination may or may not reveal the presence of Round Worm in the intestine, but certain definite changes are noted in the lungs and liver, coming from the migrating young worms.

Distribution—The Ascaris lumbricoides is found wherever pigs are reared. Very few herds are entirely free from the pest. Pigs that are raised under strict hygienic conditions are much less infested than those reared on farms where no attention is paid to the hygiene of the farm yard.

Pig infested with Round Worms

I am lop-eared and pot-bellied. Nobody loves me. The worms think I am useful as a home and the Boss thinks he owns me. The worms are certainly putting one over on the Boss. If I ever get up to bacon weight, it will be during my old age.

Control and Prevention—One wormy pig will seed down with worm eggs every foot of pen floor space, of yard space and pasture area over which it may roam. One female Round Worm in the intestine of a pig will each day pass out approximately 20,000 eggs. Ten female worms would be good for a production of over a million a week. The fertility percentage of the ascarid eggs is very high, and given suitable conditions nearly all will become vermiform, that is capable of infesting any pig that might take them up. This rapid reproduction suggests a line of action in control—stop worm egg production by destroying the worms in the intestine of the pig. Begin with the brood sows. The sow should be given a suitable vermifuge at a time not later than two weeks before she is due to farrow. Various substances can be used as Tetrachlorethylene, the Nema Capsule, Santonin, Arecanut, or Oil of Chenopodium. Two days after dosing, the sow should be washed with soap and water, in order that her skin and hair be free of worm eggs. With worm egg production stopped, and the sow's body clean, she should be moved to a pen that has been specially prepared for her to farrow in. The point to keep in mind in preparing a farrowing pen is to remove or destroy all the worm eggs that are on the floor of the pen. This is best done by scraping and then scrubbing with hot water and lye (30 gallons of hot water to 1 pound of lye). With worm egg production stopped the sow's body surface free of eggs and a clean pen for the young pigs to be born in, the litter will have a good chance to be free of Round Worm infestation, and if further protected until they are four months old they will be able to make normal gains. Protection for the young pigs is best given by rearing them on land on which swine have not been for at least two years, or keeping them in pens that have been specially scalded out until such time as they have acquired a fair degree of immunity (usually when four months old). If pigs are to be moved from the pen that is worm egg free to a clean pasture, care should be exercised to see that contamination is not picked up on the way, by allowing the sow or the pigs to walk through dirty yards, or pens. The moving is best done by loading the sow and the pigs into a suitable crate and hauling the same to the new location. Worm eggs stick, and a sow can carry enough on her feet to seed down the new location, so use the crate and stone-boat or wagon. Pigs that are reared free of Round Worms up to four months of age will not be seriously handicapped by later infestation. Old pig pens, old yards and wallows, the sanitation of which has been neglected for years are a menace to the well-being of the young pigs, in that such places harbor many millions of Round Worm eggs. Keep the young away from such places. Build colony houses and hurdles or portable fence, and set apart an acre or two of clover land on which to raise the young pigs. Remember that a young pig can pick up enough worm eggs in an hour around an old yard or pen, to fill him full up with worms a few days later. It is a good practice to give the pig at weaning time a capsule containing a vermifuge, as tetrachlorethylene, and repeat same in ten days. This double treatment will give protection until the pig is strong enough to withstand the worms. Pigs are easy to handle when young, so the dosing can be done at this time with but little expenditure of labour or material. Old pigs are not so easy to handle and therefore require special equipment for restraint and dosing.



Administering a Capsule to a Young Pig

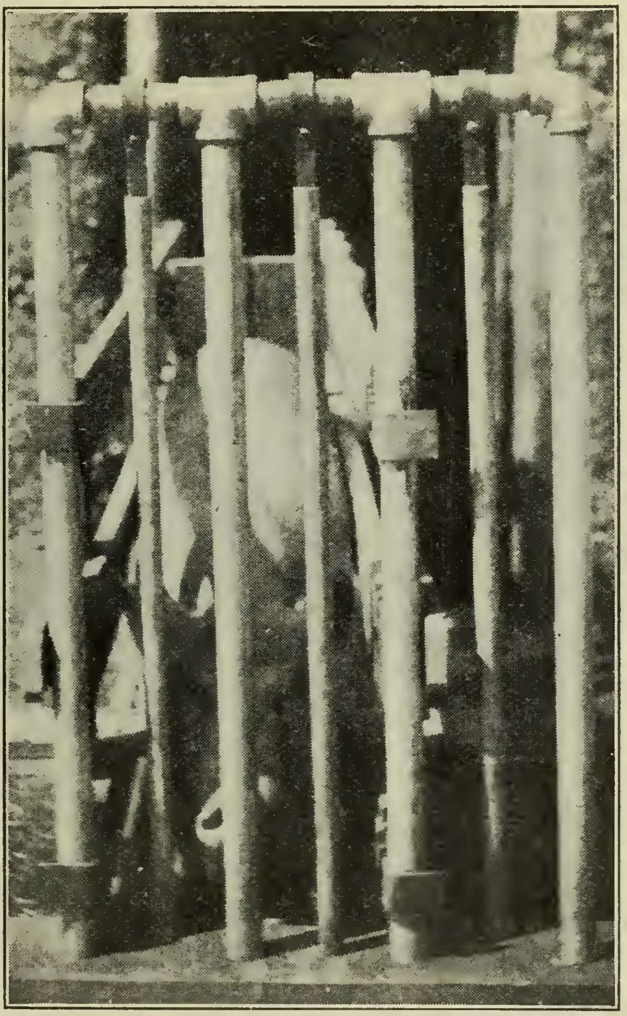
I.—Gag made of hardwood ¾-inch thick, 2 inches wide, and 12 inches long. The opening is 3 inches long by ¾ inch wide, large enough to pass in a capsule, pill or electuary.

II.—Spreader made of iron, used for pigs up to 250 pounds in weight, made of ¾ x ¼ inch iron. For pigs of large size use ¾ x ½ inch iron and make a correspondingly larger instrument.

III.—Pig held in position by one man, pig's mouth held open with jaw spreader while the capsule is being placed.

IV.—Capsule forceps made of 10-gauge steel wire.

Administration of Vermifuges to Pigs.—The pig has a peculiar, narrow throat, and care must be taken in dosing. Thin liquid medicines are always dangerous, as such are apt to enter the trachea (wind-pipe) and suffocate the pig. In giving free running liquids do so slowly and give the pig its own time to swallow. Gelatin capsules containing drugs can be administered safely to pigs and with comparative ease. Thick viscous liquids like castor oil or molasses can be used as carriers of drugs with no risk to the pig. A pig under 200 pounds in weight can be handled by a man strong enough to set it on its tail end, and then hold it by the ears as shown in the accompanying illustration. The Veterinarian forces the pig's mouth open with a spreader or gag and inserts a capsule well back over the base of the tongue. Heavy liquids, as oil of chenopodium mixed with castor oil, are best administered with a dose syringe, while the pig's mouth is held open with a spreader or gag. Pigs over 200 pounds in weight are best handled in a crate or squeeze (see illustration). A snare or line over the upper jaw is necessary to hold and elevate the mouth to the level of the shoulder tops. Pigs will squeal in this position (on their four feet) and care must be taken not to force the capsule into the trachea. Drugs in powder form can always be mixed with molasses or castor oil and placed on the base of the tongue of a squealing pig. The practice of mixing drugs with small quantities of feed is not as efficient as the individual dose in a capsule or electuary unless care is taken to see that each pig gets its dose.

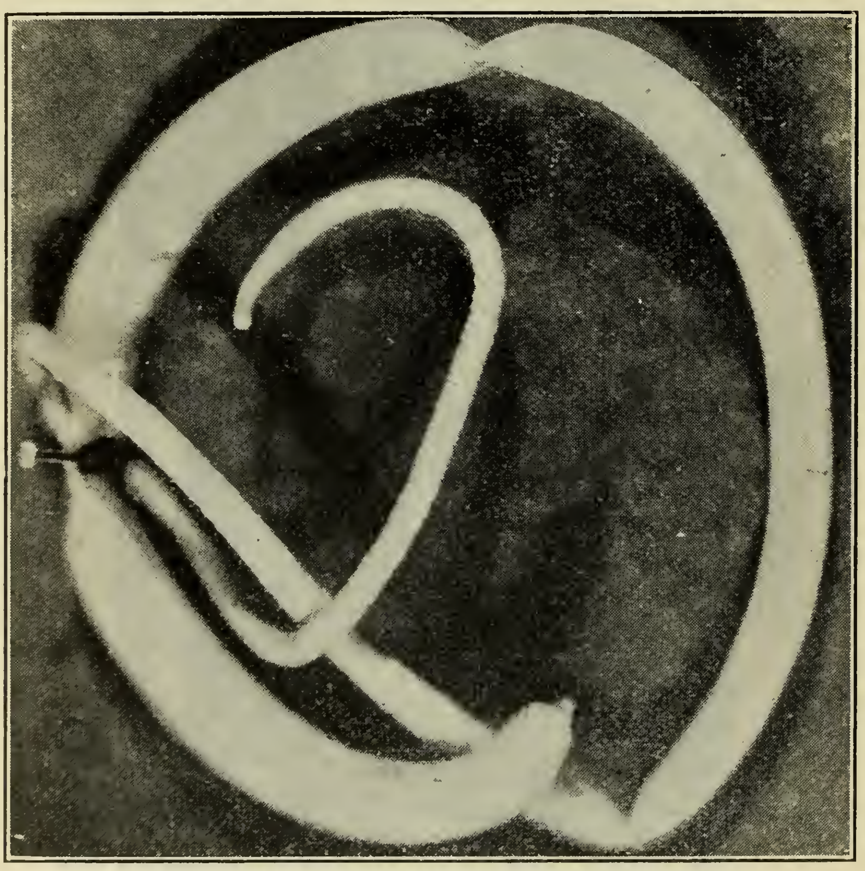


Front view of an adjustable squeeze, very useful as an aid in holding pigs while a dose of vermifuge is being administered

The Thorny Headed Worm of Swine

(*Macracanthorhynchus hirudinaceus*)

Description.—The colour varies from white to a bluish white, and the body surface is annulated. In size the adult females range from 7 to 16 inches long, while the males are much smaller and seldom exceed 3½ inches in length. The anterior body diameter for the female varies from one-third to one-sixth of an inch, while that of the male ranges from one-fifth to one-eighth of an inch. The posterior portion of the body of this worm is much thinner than the anterior portion. The head of the Thorny Headed Worm consists of an armed proboscis that can be protruded or invaginated. The proboscis is furnished with five rows of hooklets, strong and thorn like. This worm has no intestinal tract, the body cavity being entirely occupied by reproductive organs. The eggs are oval, and quite large measuring 95 to 110 microns long by 50 to 55 microns wide.



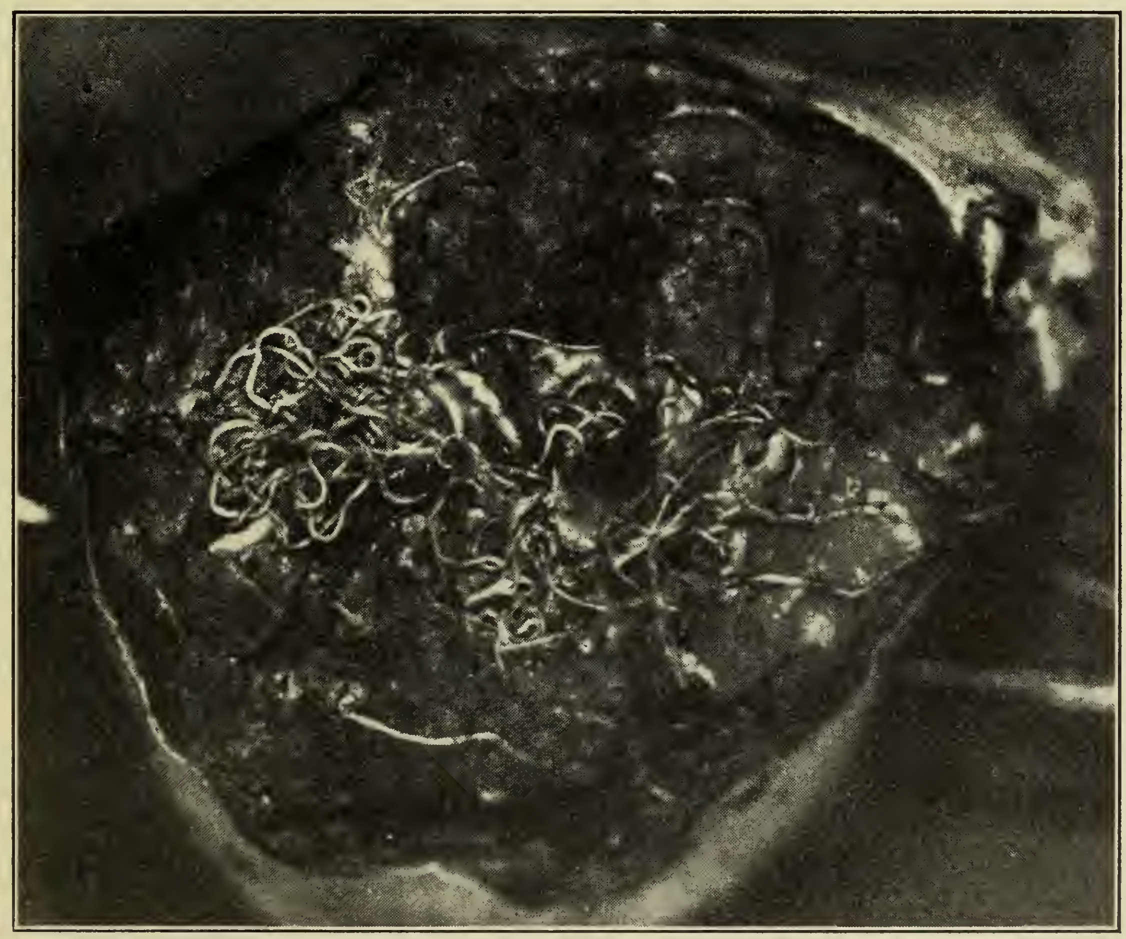
The Thorny Headed Worm

Life History.—The eggs after fertilization within the body of the worm pass out through the vagina and are then free in the intestine of the host pig, to be expelled with the feces. Various ground beetles feeding in the manure from the infested swine, take up the vermiform worm eggs, the shells of which are dissolved off or ruptured during the passage through the insect's digestive tract, releasing the embryo worm. The young worm works its way through the insect's intestinal wall and enters the body cavity to encyst and develop to the infective stage. The common June Beetle is the principal intermediate host for this worm. Pigs will root all day in sod looking for the large white grubs or June Beetles, and on eating such become infested with the young Thorny Headed Worms. The young worm on being released in the intestine of the pig attaches itself by boring into the mucosa of the intestine with the thorny proboscis, grows to maturity and creates conditions very unfavourable to the pig.

Symptoms of Infestation.—Pigs infested with the Thorn Headed worm have a very irregular appetite, are restless and squeal continually due to pain caused by the presence of the attached thorny proboscis of this worm. Pigs lose condition, their muscles twitch, convulsions follow and they frequently die in a few days. The perforation of the intestinal wall is not uncommon and if such occurs symptoms of peritonitis are manifested.

Prevention and Control.—On premises where infestation is known to exist, pigs should be reared in sanitary pens and not allowed to root up old sod or other land that has been used by pigs within three years. Anything that can be done to destroy the June Beetle will reduce the chance of Thorn Headed Worm infestation in the swine herd. Manure from swine that are infested, with this worm, should be burned.

LUNG WORM OF SWINE (*Metastrongylus elongatus*)



Thread Lung Worms emerging from the bronchioles in a piece of lung cut from the posterior portion. These worms spend their entire adult life in the lung.

Description.—A long threadlike smooth worm usually white in colour (sometimes stained brown), mouth small, lips two, each lip divided into three lobes, six papillae are present and surround the mouth orifice. The males are from one-half to one and a quarter inches long, while the females vary from one to two inches in length. The eggs are oval in outline and have a thick transparent shell, they vary from 60 to 100 microns long and from 40 to 60 microns wide. The egg contains a visible embryo when released by the female worm. The male worm is furnished with a two-winged bursa and two very long barbed spicula.

Life History.—This lung worm has a simple life history and does not require an intermediate host for its larval development. Young pigs become infected very early in life if the brood sow is a carrier of lung worms. Mature lung worms have been taken from a pig but four weeks old, which would indicate that infective larvae had been taken up by the pig during the first few days following birth or that the infection had been prenatal. The infested brood sow will expel quantities of lung worm larvae and eggs from her body with the feces or by coughing. These discharges will in part reach the feed trough or the breasts of the sow, either before or after becoming vermiform (infective) and from either position the young pig will take up the infective lung worm larvae while seeking nourishment. Lung worm eggs and larvae in all stages of development will be taken up by the pigs in feeding but only those that have advanced through a definite number of moults and survived become infective to the pig, a comparatively small number, but enough to keep the species going. On reaching the intestine of the pig with the injesta, the young worm will, if it succeeds in reaching the mucous membrane, burrow in and reach a blood-vessel. Once in the blood stream it may be carried to any tissue in the body. In the lungs the larvae that are to survive escape from the blood capillaries and enter the alveoli, eventually moving out into the smaller bronchii where they continue growth and reach sexual maturity in two or three weeks time. Eggs containing well developed embryos are deposited by the worms in the bronchi, these or a large percentage of them will complete their hatching process and leave the lungs by way of the trachea to be coughed out or swallowed to pass out with the feces. A sojourn in the outside air is necessary for development to the infective stage, which involves two moults. The young larvae having completed its "outside life" can withstand adverse weather conditions for a long period (over a year) while waiting to be taken up by a pig.

Symptoms of Infestation.—A short husky cough, at long intervals after the pigs are roused from their beds or after exercise is usually indicative of Lung Worm. In severe infestations there may be paroxysms of coughing and the discharge of seromucoid secretions. If the infestation is light there are no noticeable symptoms, while a moderate infestation will bring all the evidences of general unthrift. Intense infestations with the usual bacterial complications may kill the pig in ten days or less.

Distribution.—The Lung Worm is quite common in large herds, where many pigs are kept in the same pens or on the same ground year after year. Where but one or two brood sows are kept and these given considerable liberty as to range and living quarters little trouble is experienced with Lung Worm.

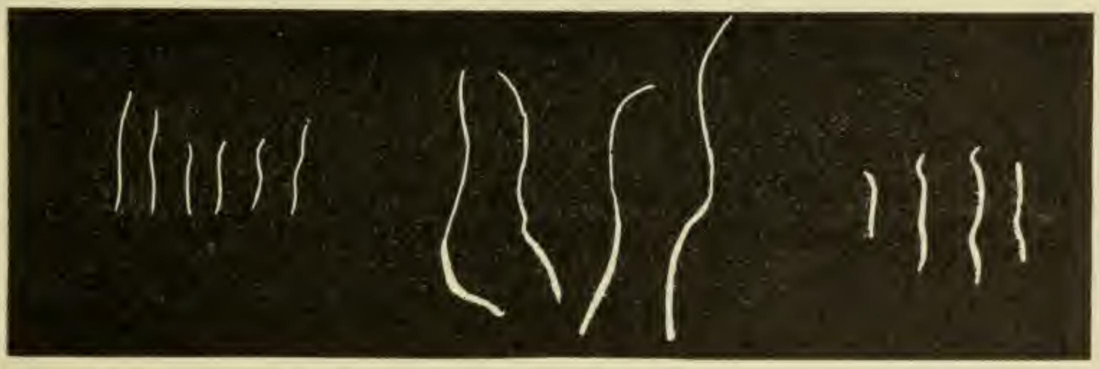
Prevention and Control.—Keeping pigs away from their own body discharges or those of other pigs infested with Lung Worms is the policy of protection that should be adopted by all persons raising swine. The close confining of pigs in numbers in soiled pens and contaminated yards makes it impossible for the pigs to keep infection out of their bodies. A clean start in life, that is being born of a worm free mother, in a worm free pen and then required to live in a sanitary way, puts the young pig beyond the Lung Worm handicap. The breeder that has Lung Worm free breeding stock, and premises that have not been contaminated by lung wormy pigs for at least three years will have no trouble with Lung Worms providing that contamination is not carried in with purchased stock, or with sows brought in for breeding, or in filth carried on the boots of people moving from farm yard to farm yard. The breeder that purchases stock to strengthen his herd, neglecting the consideration of the possible introduction of Lung Worm infestation may bring trouble into his herd. A microscopical examination of the discharges from pigs will usually determine the presence or absence of worm infestation. The Veterinarian of your district will undertake such examinations.

(a) The use of worm free breeding stock.
(b) High degree of sanitation about the premises.
(c) Adoption of the Colony House System of rearing swine on uncontaminated ground.
(d) The liberal use of scalding water on the pen floors of the piggery every three weeks.
(e) Causing infested pigs to breathe the fumes of sulphur, tobacco, pine tar, turpentine, eucalyptus or other similar bronchial irritants, to cause paroxysms of coughing, then moving the pigs to a clean pen or lot. Last pen occupied should be thoroughly scalded. Treatment to be repeated frequently. The supervision of a competent veterinary practitioner is strongly recommended, for this work.
(f) The use of intratracheal sprays consisting of aqueous, oily or volatile solutions that are antiparasitic.
(g) The use of respiratory disinfectants.

LUNG WORM OF SWINE (*Choerostrongylus brevivaginatus*)

Description.—This Lung Worm is approximately the same size and has a head and posterior extremity very much like those of the *Metastrongylus elongatus* described in previous paragraph. The life history of the *Choerostrongylus brevivaginatus* is similar to that of the *Metastrongylus elongatus*, and the same control measures apply. See previous paragraph.

STRONGYLINA STOMACH WORM OF SWINE (*Arduenna strongylina)*



Stomach Worms Whip Worms Nodular Worms

Description.—A small white worm, inhabiting the pyloric region of the stomach and upper small intestine of swine. The males may attain the length of three-fifths of an inch, while the females vary from three-fifths to seven-eighths of an inch in length. The cuticle of this worm is marked with transverse striae. The caudal extremity of the male is curved and furnished with two wings and numerous papillae. The eggs of the Arduenna strongylina are oval in outline, 34 to 40 microns long by 20 microns wide, and the embryo is visible at the time of deposition.

Life History.—The adult female resident in the stomach or small intestine releases her eggs, which pass through the alimentary canal with the injesta, to be finally carried out with the feces. The feces on the soil are attacked by various beetles of the order Coleoptera, that live on the ground surface. The beetles take the worm eggs in while feeding on the fecal matter. Under favourable conditions the embryos are released and invade the body cavity of the beetle, where they develop through three stages and become infective. Pigs consume large numbers of beetles while feeding or rooting over the soil of the yard or pasture and should a beetle contain within its body an encapsulated infective larvae the pig eating same will become infected with this parasite. On reaching the stomach of the pig, the capsule protecting the larvae is dissolved off releasing the larvae. The larvae now free attacks the mucous membrane of the pyloric section of the stomach or the small intestine, burrowing into the same and establishing between it and the muscle layer. Dark red areas appear where a number of worms locate. Bacterial infection frequently follows their invasion and ulcer-like areas develop. The greater part of the worm is buried in or under the mucous membrane.

Symptoms of infestation.—Pigs heavily infested with this worm will give evidence of great thirst, restlessness and do not feed well. A microscopical examination of the feces from suspected cases, for worm eggs, will prove or disprove the presence of the worm. A post-mortem examination will reveal, if the subject is infested with the Strongyline Stomach Worm, a thick pseudo membrane adherent to the pyloric wall at the point where the worms have attacked the mucous membrane.

Prevention and Control.—Sanitation is of great importance in dealing with this worm. Fecal matter should be removed from the pens and yards daily and put at some distance from the yards and pens where the pigs are housed. The use of poultry to keep the yards clear of beetles will help very materially in keeping down infestation. The removal of loose stones and boards or other debris likely to shelter beetles should be practiced. The use of vermifuges, while beneficial cannot be fully efficient due to the burrowing habit of the worm. Repeated dosing is advised. The following substances can be used: Tetrachlorethylene, or Oil of Chenopodium or Oil of Turpentine.

THE SIX WINGED STOMACH WORM OF SWINE (*Physocephalus sexalatus*)

This worm is somewhat smaller than the Strongyline Stomach Worm, being shorter and more slender. Males are less than one-third of an inch in length and the females may attain a length of three-quarters of an inch. The eggs are oval in outline, flattened at the poles, measure 30 to 35 microns long by 13 to 15 microns wide. Visible embryos may be seen at the time the eggs are deposited in the stomach of the host animal.

The life history of this worm is much the same as that described for the Strongyline Stomach Worm of Swine, and the same control and prevention methods are indicated.

WHIP WORM OF SWINE (*Trichuris suis*)

Description.—A small whip-like white worm, resident in the cecum and colon. The males may attain a length exceeding one and a half inches, while the females vary from one and a half to two inches. The anterior portion of the body of the male is thin and thread-like, it comprises about five-eighths of the total body length, the posterior portion of the body is quite stout. In the female the thin anterior portion of the worm is about two-thirds its total length and the posterior body is not so stout as it is with the male. The eggs are lemon shaped in outline and measure 50 to 56 microns long by 32 to 38 microns wide.

Life History.—The adult female worm resident in the cecum or colon of the pig, releases her fertilized eggs, which pass to the outside with the fecal discharges of the pig. Under favourable conditions of temperature and moisture the eggs become vermiform, and if taken up by another pig, the larvae will be released in the pig's stomach to be carried with the injesta back to the cecum where it grows to sexual maturity in 16 to 20 days. The Whip Worm buries its long head in the mucosa as a hold fast, while the heavy body portion floats free in the injesta in the large intestine. Some blood is taken by the worm and toxins are in all probability produced, as nervous symptoms accompany heavy infestations.

Control and Prevention.—The Whip Worm is not often found in swine that are kept in a highly sanitary way, and like the Round Worm (Ascarid), it thrives on the farms where there is any neglect. The eggs are very resistant to weather and may live for several years without losing their vitality. The sanitary measures as described for ascarid control, apply to the control of Whip Worm. It is difficult to reach the Whip Worm with vermifuges, owing to its attachment and location. Repeated treatment with such drugs as Santonin and Oil of Chenopodium have given best results.

THE NODULAR WORM OF SWINE (*Oesophagostomum dentatum*)

Description.—The Nodular Worm of swine is a small white or grey worm inhabiting the large intestine. The males may attain a length of one-half inch. The females are a little larger and range from one-half to nearly one inch in length. These worms are very common and where the infestation is light may do no damage to the older animals in the herd. In young stock the Nodular Worm is suspected of being responsible for intestinal irritation, unthriftiness and anemia. It is also believed that this worm is a contributing factor to the many cases of peritonitis seen in young pigs. Intestinal congestion is frequently noted where the infestations are heavy.

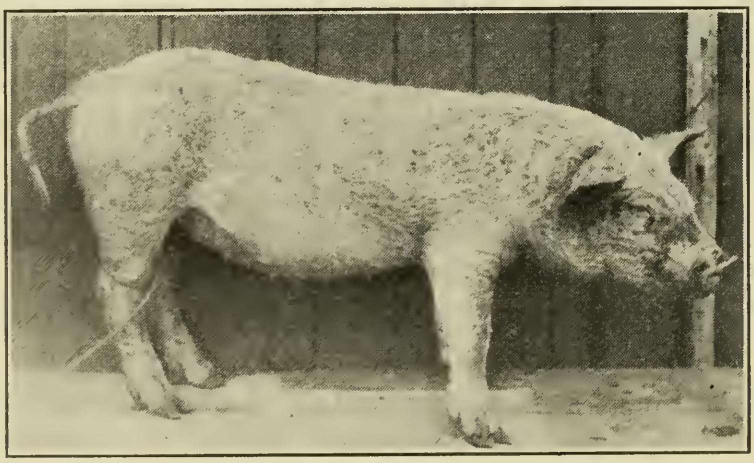
Life History.—The female worms in the large intestine of the pig, discharge their eggs, which mix with the pig's feces and pass from that animal's body. The eggs hatch and the young larvae feed on the fecal matter for three or four days, then go into a moult, following this there is a period of growth and a second moult, bringing the larvae up to the infective stage. It is then taken up by a pig, feeding from a trough or floor, passes through the stomach and small intestine, getting rid of its chitinous covering and eventually reaching the large intestine. Once free in the large intestine it reaches the mucosa and burrows in, a small nodule forming around it. The little worm is resident in the nodule for a period varying from two to six months, in that time it may grow to be one-fifth of an inch long. Leaving the nodule the young worm enters the lumen of the bowel, attaches to the mucosa and grows to maturity in two or three weeks time. The sexes mate and egg release follows. The eggs are eliptical in outline and measure 60 to 66 microns long by 35 to 42 microns wide.

Prevention and Control.—Sanitation is most important. Keep pigs from feeding off dirty floors. Keep the pens dry and well bedded. Remove the manure from the pens and yards daily and have it placed where the pigs cannot reach it. The use of floor gratings and crates to prevent infestation occurring in breeding stock is recommended. Medicinal treatments have not been effective in removing this worm due to its location and protected position. The selection for breeding of animals that have the instinct to keep clean is a factor favouring the pig in keeping clear of the Nodular Worm. Pigs vary greatly in habits. Those of cleanly habits should be the most desirable from the breeder's standpoint.

TAPE WORMS INFESTING SWINE

Tape worm infestation in swine in the Province of Ontario is not common and is limited to the larval stage of the following: *Taenia solium*, *Taenia Hydatigena*, *Multiceps multiceps* and *Echinococus granulosus*. The infestations are so infrequent that condemnations of carcases, by government inspection at the abattoirs is a rare occurrence. The larvae (bladderworm) of Taenia solium, is more frequently found than the others, it occurs chiefly in the abdominal muscles, the massater muscles, the diaphragm and the heart. The primary stage of the Taenia solium is spent in the intestine of the human. Failure to properly dispose of human excreta on some farms is responsible for the spread of this tapeworm. The primary stage of the Multiceps multiceps, the Taenia hydatigena and the Echinococus granulosus is spent in the intestine of a dog. Farm dogs should be regularly treated for tapeworm and safe disposal made of all discharges, to prevent the tapeworm eggs being taken up by swine.

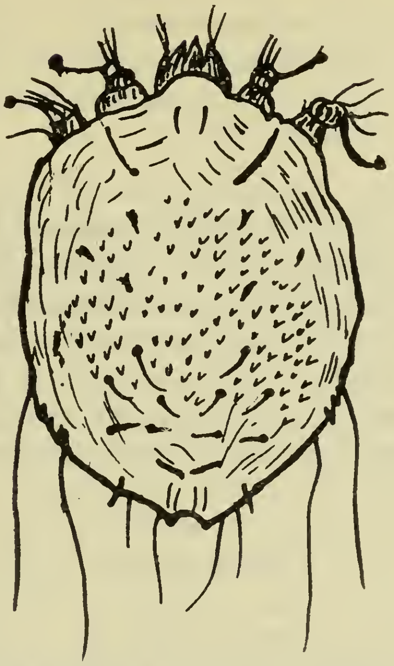
MANGE



A victim of lice and mange mites. Pigs in constant misery from the irritation of external parasites cannot be profitable. Give the pigs a chance to keep free of external parasites by providing a Rubbing Post and a supply of crude oil.

Two varieties of Mange Mite attack swine in Ontario, the Sarcoptic mite and the Demodectic mite. The Demodectic form of mange in swine is not common, but the Sarcoptic form is very frequently seen. Male animals that are kept for service in a community, are often very badly crusted with mange, and serve as distributors of the pest. Herds are frequently seen in which every animal old and young is a victim of mange. The loss through the neglect of owners to take such measures as will protect their herds from this irritating pest, amounts to many thousands of dollars each year.

Sarcoptic Mange (*Sarcoptes scabiei suis*)



Mange Mite (*Sarcoptes scabiei suis*). Enlarged 120 diameters.

The Sarcoptic Mange mite can be seen with the unaided eye, as a very small moving grey speck in the scales scraped from an infested area. Pigs become infected about the eyes and base of the ears, and from this location the infection spreads backwards, and will, if not checked, cover the entire body with a hard shield like grey scaly mass. The scales form wherever the mite has been at work and result from its habit of penetrating into the skin with its stylet causing erythema, which is followed by the formation of vesicles and crusts. It is beneath the crusts that the Mange Mite is to be found.

Control and Prevention.—Sarcoptic Mange can be successfully treated by the use of stock dips that are of a penetrating nature. Any of the following will, if properly applied, give satisfactory results.

(a)	Sulphur	2 pounds
	Oil of Tar	8 ounces
	Raw Linseed Oil	1 gallon

The mixture is heated and applied quite warm. Pigs should be well washed with soap and water to remove as much of the scale as possible, when dry apply the mixture with a stiff brush, leave for ten days, then wash off, dry and repeat the treatment.

(b)	Creosote	1 part
	Raw Linseed Oil	19 parts

Wash the pig, dry, and apply with a brush.

(c)	Creosote	1 part
	Lard	25 parts

Wash the pig, dry, and apply with a brush.

(d)	Lime and Sulphur Dip.	
	Flowers of Sulphur	3 pounds
	Unslacked lime	1 pound
	Water	10 Imperial gallons.

Submerge the pig, that the dip may reach every wrinkle about the face and head.

Pigs should be kept away from filthy wallow holes, and given clean dry quarters. Pens should be sprayed with a strong disinfectant at frequent and regular intervals. A Crude Oil Rubbing Post should be set in every pig yard or pen, that the pig can go and take a rub whenever it feels an itch.

FOLLICULAR MANGE (*Demodex folliculorum suis*) RED MANGE

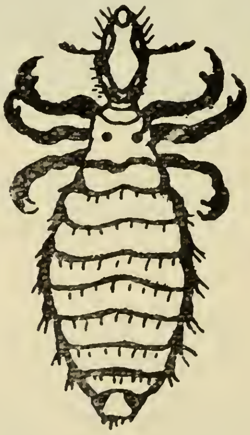
The Demodectic or Red Mange is caused by a mite so small that it is not visible to the unaided eye. This mite burrows into the skin by way of a hair follicle. The skin becomes red, hairless, thick and crusted. The irritation set up in the inflamed area is most intense.

Control and Prevention.—A high degree of sanitation about the premises and the immediate removal of all animals showing the presence of this form of mange. Treatment of individual cases is difficult as the young mites are out of reach of the ordinary dip remedies, and the time and attention required is too great to expend on an animal of comparatively low value. The disposition of all infected animals by slaughter as soon as it is possible to market them is advised. Pens should be thoroughly cleaned and disinfected and not used for pigs for six weeks after being occupied by mangy swine.

PEDICULOSIS

The common Hog Louse is responsible for a higher cost than need be, in the production of pork on many farms. The pig with a continual itch cannot be a profitable feeder and the general neglect on the part of swine feeders to subdue this active blood sucking pest is costing them a lot of money. One pair of lice let have their way for three months will fill a piggery with their progeny, very much to the discomfort of the pen imprisoned pigs. The lice being very active blood suckers, brings about a condition of pruritis, causing the pig's skin to be covered with papules and scales. The infested pig will be restless, continually rubbing to get relief and will be unable to sleep either day or night. It is the pig's business to lie quiet and grow fat, but how can it do so if the owner allows lice to worry it day and night. The profit on a litter of hogs of fattening age may be entirely lost, or young pigs may die due to neglect to control lice. There is another reason why lice should not be tolerated, they are carriers of bacterial diseases.

THE HOG LOUSE (*Haematopinus suis*)



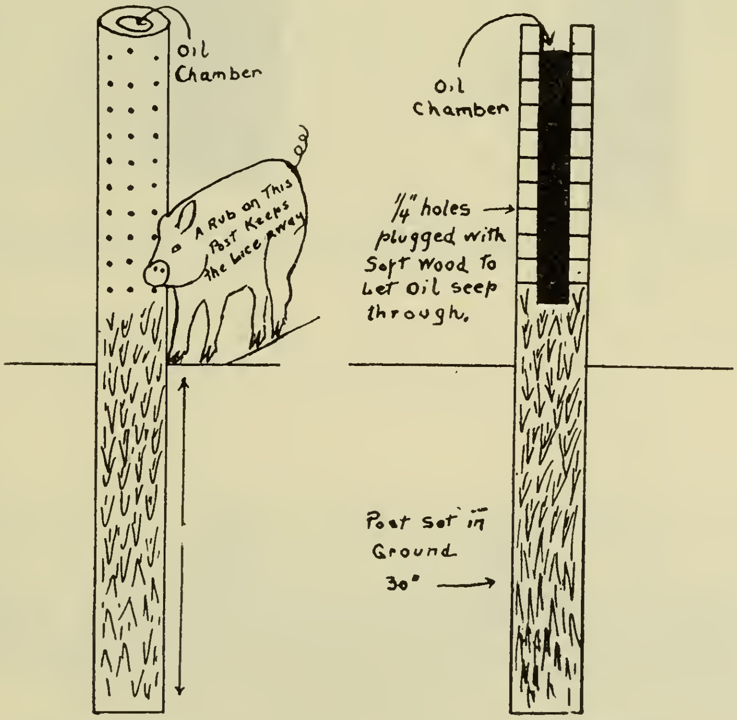
HOG LOUSE (*Haematopinus suis*), enlarged (x9)

These lice cause much discomfort to young pigs and are responsible for considerable loss. Lice are easily controlled by keeping the premises clean and using oils on the body of the pig. Crude oil is highly satisfactory and cheap. Give the pigs an oil post and let them rub.

Description.—The Hog Louse is very large and active. The females are one-fifth of an inch long and measure about one-tenth of an inch across the widest part of the abdomen. The males are a little smaller than the females. The head is cone-shaped, very long and yellowish-grey in colour. The thorax is brown in colour and broader than long. The abdomen is oval in outline and yellowish grey in colour.

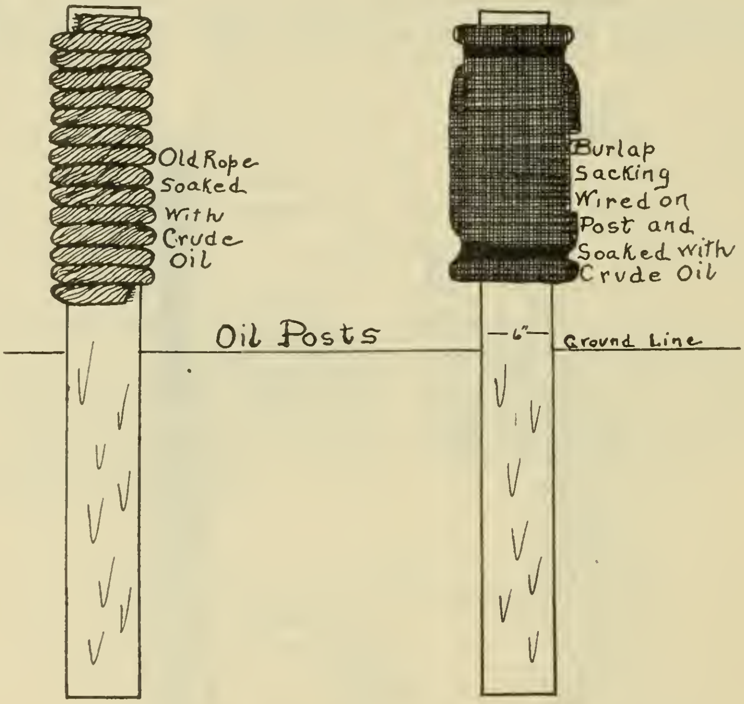
Life History.—These lice live on pigs both old and young, migrating from animal to animal when opportunity offers or spending a lifetime on one individual. The sexes mate on reaching sexual maturity, and the female louse soon starts egg laying. The fertilized eggs are produced at the rate of eight to twelve a day, and each egg is glued to a hair near the skin. The eggs hatch in ten or twelve days' time if the pig is housed under conditions favourable to the breeding of lice. Many eggs are produced by each female, and if but fifty per cent. hatched and matured, the offspring in four generations would be over half a million lice, from one pair in three months' time. On emerging from the egg the young louse which is a miniature of the parent, seeks a thin skinned area where it may enter its proboscis and obtain blood. The young louse goes through three moults, taking in all about three weeks to reach sexual maturity.

Prevention and Control.—Measures to remove lice from the herd should embrace activities directed in the following lines: (1) the destruction of the lice present on the pigs; (2) destroying the eggs; (3) preventing reinfestation by cleaning up the pens and keeping infested pigs away from the premises. The Hog Louse is easily destroyed and the pig will do most of the work connected therewith if a suitable oiler is provided. Oilers may be home-made or purchased contrivances to serve the purpose of supplying a limited quantity of crude oil to the skin of any pig that has the desire to rub. Crude oil may be applied with a brush or swab, it is cheap and highly efficient. Kerosene Emulsion can


Oil Chamber
A Rub on This Post Keeps the Lice Away
Oil Chamber
1/4" holes plugged with Soft Wood To Let Oil seep through.
Post set in Ground 30"

Oil Post made by boring a two inch or three inch hole in one end of a post, to serve as an oil chamber. This oil chamber is tapped by boring a series of quarter inch holes from the outside into it and plugging these small holes with soft wood, to allow the oil to seep through. Just enough to deliver a little oil to the pig's skin.

be used against the Hog Louse and if applied as a dip is very effective. It is made as follows:—dissolve 8 ounces of laundry soap in one gallon of boiling water, than add two gallons of kerosene (coal oil), mix well while hot. This is the stock solution. For use add nine gallons of soft water to each gallon of stock solution. Kerosene Emulsion is best used in the dipping tank, however a fair application can be made to the pig's body through the use of a spray pump or sprinkler can. Oily solutions should be applied in the evening or the pigs kept in the shade and not exposed to the bright sun. Blistering results if a freshly oiled skin is exposed during the heat of the day. Stock dips made from coal tar preparations as creolin, lysol or kresol can be used in the dipping tank with excellent results, as such not only destroys the lice but cleans the lesions, reduces the irritation and promotes healing. Whatever treatment is applied, it should be repeated in eight or ten days to destroy any lice hatching since the first application was made. After dipping or spraying the pigs put them on clean ground and give them a louse free shelter. Clean up the old pens and yards, soak the floors and walls with a strong disinfectant to destroy the lice that are always present in such places if recently occupied by lousy pigs. A three weeks' rest for a pen or yard will give the lice time to die.


Old Rope Soaked With Crude Oil
Oil Posts
Burlap Sacking Wired on Post and Soaked with Crude Oil
6"
Ground Line

Oil Posts. A post 6 inches in diameter or larger is set in the ground, or pen floor, or on the pen wall, and its upper end covered with rope or burlap to hold the oil. The rope is kept moist by weekly applications of oil and the pigs do their own rubbing.

VERMIFUGES SUITABLE FOR SWINE

Tetrachlorethylene.

Administered in capsule after starving the pig for 18 hours.

The dose of Tetrachlorethylene is as follows:—

For pigs	up to	50	pounds	in weight	use	1	CC.
"	"	100	"	"	"	"	2	"
"	"	200	"	"	"	"	5	"
"	"	500	"	"	"	"	10	"

Areca Nut (Fresh pulverized).

Administered in a handful of feed after starving the pig for 24 hours.

The dose of Areca Nut is, one grain for each pound weight of pig. That is a pig weighing 100 pounds would take 100 grains of Areca Nut.

Benzine.

Administered in a handful of feed or a little milk, after starving pig for 24 hours. The dosage is one to three drams of Benzine, for pigs from 50 to 150 pounds in weight, that is one dram to a pig weighing 50 pounds, two drams to a pig weighing 100 pounds and three drams to a pig weighing 150 pounds.

Oil of Chenopodium (*Wormseed*).

Administered with Castor Oil after starving pig for 24 hours.

The dose of oil of Chenopodium is one fluid dram to a pig weighing 100 pounds, given with two ounces of Castor Oil. Reduce the dose for smaller pigs and increase for larger ones.

Santonin.

Administered in a handful of feed, after starving the pig for 24 hours.
The dose is as follows for pig weighing 100 pounds.

Santonin	2½ grains
Areca Nut	1 dram
Calomel	½ grain
Soda Bi-carb	½ dram

Mineral Mixture, for use in Self Feeder.

Sulphate of Iron	5 parts by measure
Hardwood ash	20 " "
Charcoal	75 " "

Place in a box and let pigs help themselves.

Mineral Mixture, for use with feed.

Bone flour	50 pounds
Salt	10 "
Sulphur	5 "
Oxide of Iron	2 "
Potassium Iodide	4 ounces

Mix and use two pounds to each 100 pounds of grain fed.

The Colony House is easily moved to fresh ground and green crop forage. A dry location and sunlight are two very important factors in swine hygiene. The colony house excels in these factors so important to the vigor and thrift of both young and mature breeding animals. The colony house is moved to fresh ground so often as need be, and the pigs thereby removed from the location contaminated by their fecal matter which may contain many worm eggs. [See Bulletin No. 297, Ont. Dept. of Agriculture.]

Young pigs reared away from the old pens and old buildings have a much better opportunity to escape the worm handicap than those pigs that spend their early life around such places. Green feed, sunshine and pure air play a part for which there is no substitute in rearing pigs.

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Paints and Painting

By E. W. Kendall, B.S.A., Associate Professor in Agricultural Engineering.

INTRODUCTION

Color has always exerted a profound influence on mankind and he has used it in many ways and for many purposes. Ages before the dawn of history he applied it to his person, either to frighten his enemies or in an attempt to make himself more attractive. Perhaps man's first use of paint on his buildings was for the purpose of decoration but as the years passed its protective value was recognized. In modern times we use paint for these very same reasons but we probably place the greatest stress upon the fact that paint protects and so more than doubles the life of an object to which it is applied. Its value from the decorative standpoint is twofold, in that it not only gives the owner a sense of satisfaction and fulfills his craving for the beauty of color but it adds to the value of his possessions by making them appeal to others in a similar fashion.

There is no doubt at all, but that the farm with the well painted buildings is going to sell far quicker and for a much higher price than is the one where paint has not been used. One farmer recently stated that the farm had been producing just a bare living until he struck upon the happy thought of using a rather striking color scheme for his buildings. The scheme used was black with an orange trim and he followed this up by advertising his products by the catchy name of Orange Top eggs, Orange Top butter, etc.

It is undoubtedly true, that neglect to paint is caused by the fact that the job and its cost look so formidable. A farmer may hesitate to attempt it himself owing to his lack of knowledge of paint and it will be the object of this bulletin to attempt to throw a little light on the subject. There is no good reason why an owner may not do a considerable amount of painting himself as time permits, but should he wish to turn the job over to a painter, he has a choice of two methods, the more common one of brush painting or the more modern and less costly one of spray painting. This latter method has many advantages. The paint is forced into the cracks and crevices that could not be filled by brushing methods. The surface is left more even than after a brush and the time taken to do the job is many times shorter. In Ontario there are several companies that will spray paint a group of buildings in a remarkably short time and at a very reasonable cost.

Characteristics of a Good Paint.—A good paint will not be quickly affected by weather changes, once it has properly dried. It will stand considerable wear and is not affected by the ordinary expansion and contraction of the surfaces to which it has been applied. The color will be fairly permanent.

Life of Paint.—Paint that has been applied to interiors or protected situations will last for many years. Outside paint has an average life of from three to five years, depending upon the quality of the paint, conditions of the weather and surface at the time of painting and the exposure. It is by no means uncommon however, to find painted surfaces in good condition that are seven to ten years old.

A street sign many years old. The paint has protected the letters S and T, while the unprotected wood has worn away.

When to Paint.—Many people favor the fall rather than the spring for painting time. The reasons given are, that the painter is less rushed and will do a better job, that the weather is nearer the proper temperature, 70°F, and that there is less chance of sudden storms. To this might be added the facts that there are fewer insects flying around and that the warm days and cool nights help to harden the paint film.

Composition of Paint.—Paint consists of a solid portion called the pigment, suspended in a liquid portion called the vehicle. When the liquid oxidizes and dries it becomes hard and helps to hold the pigment securely to the surface to which it has been applied.

PIGMENTS.—Pigments may be divided into three classes.

1. Color pigments which impart a color or tint to the paint.
2. Body pigments, such as white and red lead, which give the paint its lasting qualities.
3. Extenders or pigments which are added to reinforce the paint film or to simply aid in producing a cheap paint.

Principal Pigment Color Classes.

White:— White lead, Zinc oxide, Lithopone.
Black:— Lampblack, Carbon black, Bone black, Ivory or Drop black.
Red:— Red lead, Red iron oxides such as Indian red, Turkey red and Venetian red.
Yellow:—Chrome yellow and Yellow ochre.
Blue:— Prussian blue, Ultramarine blue, Cobalt blue.
Brown:— Raw and Burnt sienna, Raw and Burnt umber, Vandyke brown and Iron oxide brown.
Green:— Chrome greens.

Painting a roof by spraying.

The white pigments are most commonly sold in a paste form, ground in oil. Cans or kegs holding from ½ lb. up to 100 lbs. may be bought. Lithopone is an exception to this in that it is usually sold under a trade name as a ready mixed paint.

The tinting pigments are also sold, ground in oil. The containers may be collapsible tubes where small quantities are needed or half to five pound cans for larger quantities.

White Lead is the most commonly used priming paint and in many cases is the only pigment used on a painting job. On account of the fact that its paint film is soft and easily soiled and that it tends to discolor where sulphur is present, it should not be used alone around barns, poultry houses or hog-pens. In these situations about 50% of Zinc oxide is used with the white lead.

Zinc Oxide finds its greatest use in interior paints. It gives them a hard firm coat to which dirt does not readily stick. It is used largely in the manufacture of enamels. Its great qualities are its durability and permanence of color.

Lithopone is extremely opaque and has great spreading qualities and is used in combination with zinc oxide as an inside flat paint. As now made, it is light proof and is used in many outside paints.

Red Lead has its greatest value as a priming coat on iron and steel. Its value lies chiefly in its adherent quality. On the farm it finds its chief use as a priming coat on galvanized surfaces. It should however be used as a primer only and should always be painted over with a coat of outside paint as by itself it does not stand exposure well.

Color Pigments.—Some of these pigments fade very readily and so require frequent renewing. These are Chrome yellows, Chrome greens and Prussian blues. The more permanent pigments are Raw and burnt umber, Raw sienna, Indian and Venetian red, Lampblack, Ivory and Drop black.

Paint Vehicles.—The liquid portion of paints may consist of oils, thinners and driers.

Paint Oils.—Linseed oil is the standard paint oil and may be sold as "boiled" or "raw" oil. It does not dry in the same sense that water will dry or evaporate from a surface but a chemical action takes place in which oxygen of the air combines with the oil to form a tough, elastic skin. As raw oil dries slower than boiled oil, it is almost always used with a drier. Where boiled oil is used it is not necessary to use a drier. Ordinarily, boiled oil is used for inside uses and raw oil for outside uses. Always specify "pure linseed oil".

Thinners.—Turpentine is the most commonly used thinner. It serves various purposes, such as increasing the spread of the pigment, causing the paint to dry quickly and assisting the paint to penetrate the surface to which it is applied. Turpentine substitutes are special petroleum products with a distillation range about the same as turpentine. They are generally used either alone or mixed with turpentine.

Driers.—Brown Japan or Japan Drier quickens the action of the drying or hardening of the paint film and is always used when raw linseed oil is a vehicle. They must not be used in excess, however, as rapid deterioration of the paint film will result.

Paint Brushes

To do good painting one needs good brushes as well as good paint. Good brushes are expensive but if given the proper care will outlast several cheap brushes and at the same time do much better work.

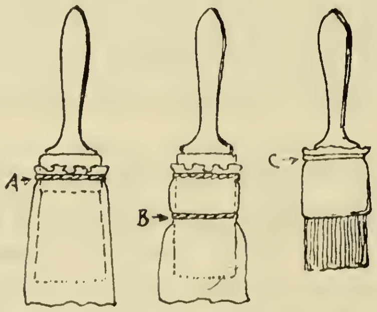


Fig. 1. Bridling Brushes.

It is generally conceded that the best size of a brush for the bigger jobs is a round brush about 2" diameter with 6" bristles. This brush will have to be "bridled" and an easy method is by use of a piece of cloth. This is wound around the brush and tied firmly to the ferrule as in fig. 1A. A second cord is now wound around cloth and brush about 3" below the tip of the bristles as in fig. 1B. The loose part of this sleeve is now turned back over the cord B and bound tightly to the ferrule above A, fig. 1 at C.

Flat brushes are the most generally useful especially where speed is necessary. For working around window sash a special sash brush is often used.

CARE OF BRUSHES.

On buying:—Shake out all dust, rinse in turpentine and hang up to dry in a dustless place. When dry, wrap in paper and place flat on a shelf.

While in use:—Dip about an inch only into the paint, slap the brush against inside of can and do not drag it too heavily over the sharp edge. This sets the paint into the brush and helps prevent dripping. Hold brush with fingers well down on the ferrule and keep it approximately at right angles to the surface being painted. A brush should not be left standing on its bristles, for any length of time.

On stopping work for a short time:—Work out most of the paint and wrap the brush up in paper. Place where it will lie flat.

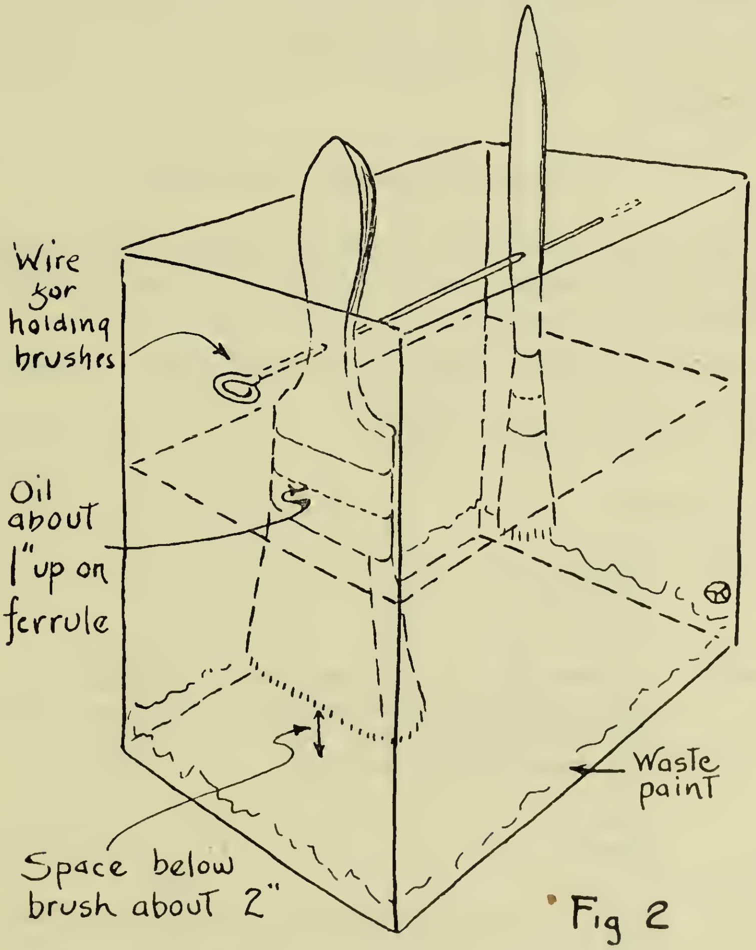


Fig 2

Wet storage of brushes.

On storing wet:—Special covered boxes may be bought or a substitute made. Hang the brushes in these so that the bristles are at least one inch above the bottom and so that the oil comes part way up on the ferrule. As paint will settle out into the box you must empty it out occasionally.

Varnish Brushes are suspended in varnish and cleaned with turpentine.

Shellac Brushes are suspended in air tight containers in shellac and are cleaned with alcohol.

Bronzing brushes are cleaned with gasoline immediately after use. If brushes are left in water they will become soft and lose their spring.

On storing dry:—Clean with turpentine. Wash in soapy water and rinse out all soap. Give a final rinse in alcohol and when dry wrap in paper. Hang up or store flat on a shelf.

Cheap brushes that have become hardened with paint may be cleaned and softened by boiling in vinegar. Good brushes may have hardened paint removed by soaking in paint remover. They should not be allowed to remain in the paint remover too long or they will soften up and become useless.

ESTIMATING THE SURFACE TO BE COVERED

Before buying paints it is necessary to estimate the area to be painted. This may be done by considering each surface of the building as a separate unit and not taking into account any openings. Walls would be rectangular units and you find the area by multiplying the length by the height. Gables are triangular units and you multiply the length by one half the height to get the area. Adding all the products thus obtained will give you the total area. The example will show how this is done. See Page 7.

SPREADING CAPACITY OF PAINTS

This varies very much according to the consistency of the paint, its color, the character and color of the surface to be covered, and the method of applying the paint, dipping, brushing or spraying.

Spreading capacity depends largely on composition. A cheap paint will not cover nearly as much surface as a good one.

The following may be used as a guide.

Surface			Square feet covered by 1 gallon
1. **Wood.**	—new—	Priming coat	420
		2nd coat	500
		3rd coat	720
	—old—	weather beaten and not previously painted	300
		new paint same color as old	720
		new paint lighter than old	500
		new paint darker than old	750
2. **Concrete.**		smooth	360
		rough	240
3. **Brick.**		hard	480
		soft	420
Metal such as galvanized iron			800

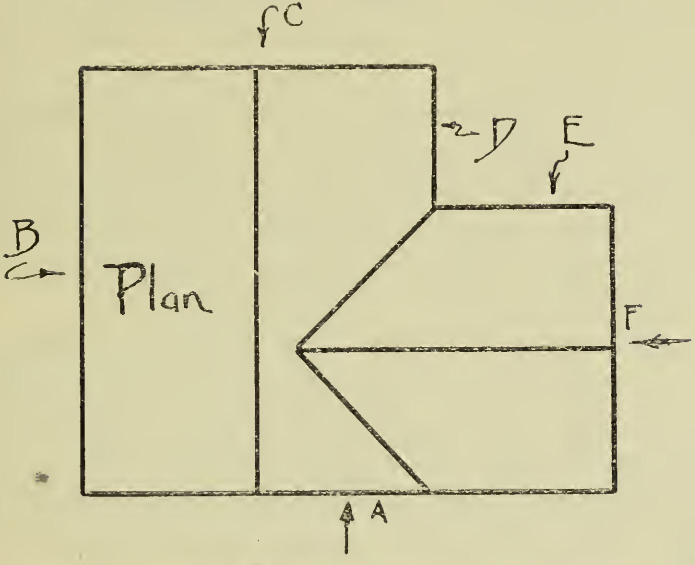
Shingles—dipped in stain ⅔ length require 2½ gallons of stain per 1000 shingles.

Covering capacity of varnish and shellac would be about as follows

Varnish. 1 gallon would cover 540 sq. ft.

Shellac. 1 gallon would cover 720 sq. ft.

Estimating Areas to be Painted. House with wing.



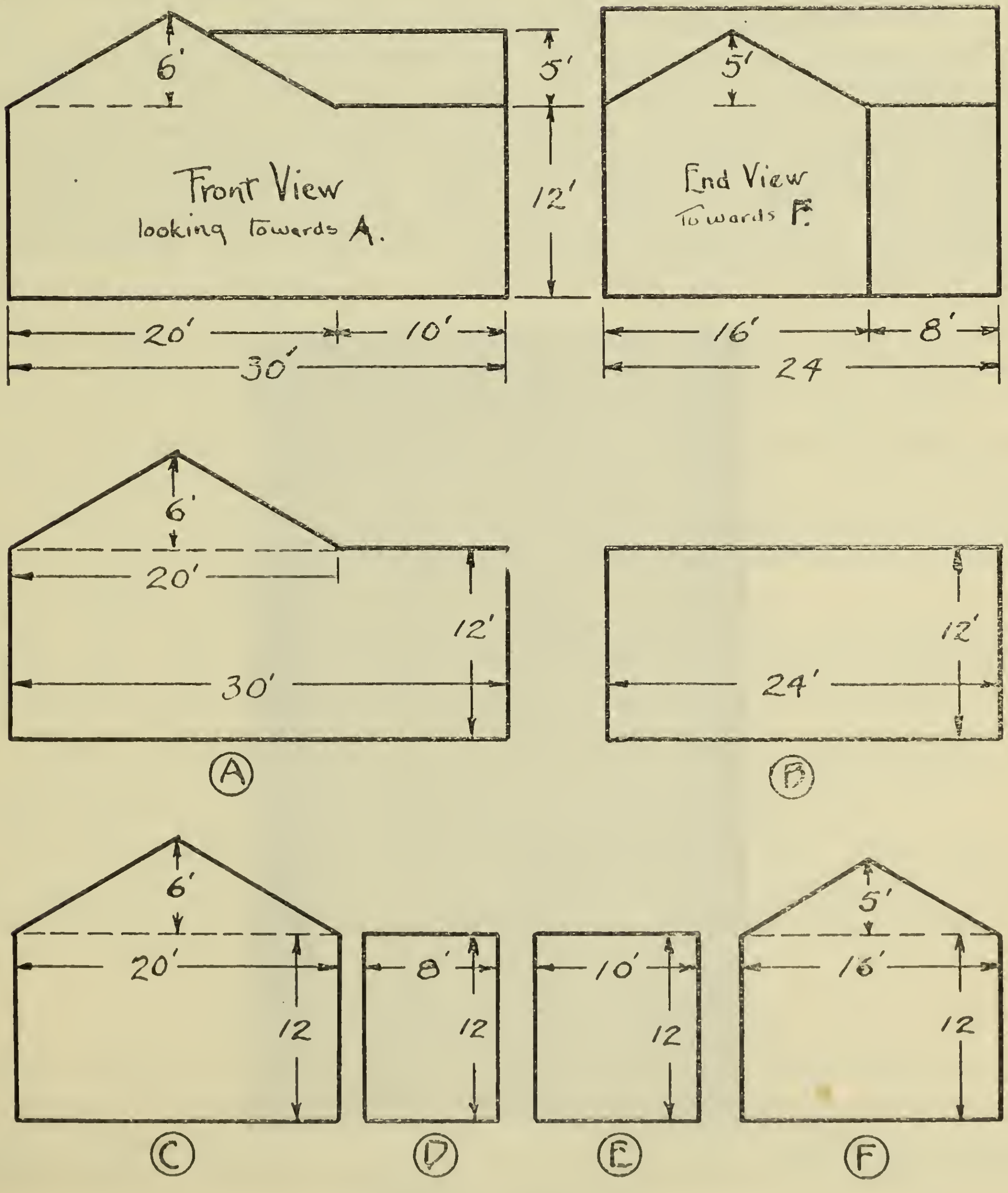
Rectangles.

A 30 × 12 = 360 sq. ft.
B 24 × 12 = 288 " "
C 20 × 12 = 240 " "
D 8 × 12 = 96 " "
E 10 × 12 = 120 " "
F 16 × 12 = 192 " "

Triangles on

A $20 \times \frac{1}{2}$ of $6 = 60$ " "
C $20 \times \frac{1}{2}$ of $6 = 60$ " "
F $16 \times \frac{1}{2}$ of $5 = 40$ " "

Total Area. 1556 sq. ft.



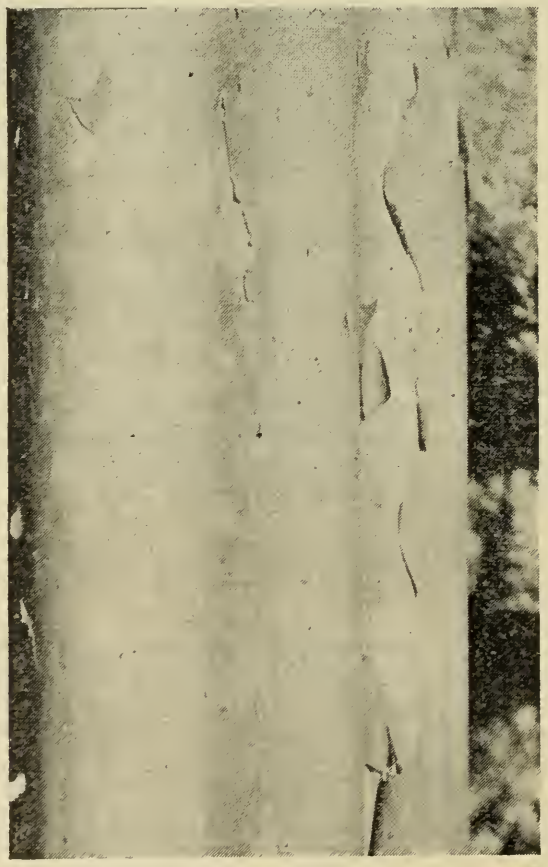
PREPARATION OF THE SURFACE TO BE PAINTED

A good painter is always particular about the condition of the surface to which he applies his paint and an amateur should be even more particular. The following treatment of surfaces cannot be too strongly urged.

New Wood Surfaces.—Paint adheres to wood largely through the hold it obtains on the tiny pores or openings in the wood surface and if these are filled up with dust, water, sap, resin or grease, the paint will eventually scale off. That being the case, new wood should be dusted off, knots painted with shellac and grease spots washed with benzene. Woods that are extremely resinous are first treated with paint thinned with turpentine and cypress used in greenhouses, with benzole.

Old Painted Surfaces.—If the surface is in good condition it may be washed, dried, lightly sanded and dusted. If the surface is scaling, a thorough scraping and brushing with wire brushes may be necessary. If this scaling is due to dampness, the cause must be removed. If due to resin, scrape the surface and treat with paint thinned with turpentine. In some cases the old paint is completely removed with a blow-torch or a paint removing liquid. The blow-torch is generally used for out of doors. This removal results in a better surface appearance.

Metal Surfaces.—Cleaning methods for metal surfaces are much the same as for wood. All loose dirt must be removed. This is especially true of rust. Many people are tempted to paint right over rust and are disagreebly surprised when in a year or so the rust begins to show through the paint. When this happens, both paint and rust have to be removed to make a job. Rust may be removed by scrapers made from old files. This scraping is followed by a brushing with a wire brush until the metal is as clean as it is possible to make it.



Paint peeling off a new galvanized iron downspout that has not been treated previous to painting.

A new galvanized iron roof should be examined carefully every six months and painting postponed until the first signs of rust appear. If painted at this time it will be possible to avoid a lot of hard work as the surface will need no special preparation except dusting. Paint will not adhere to new galvanized surfaces without special preparation. Four ounces of copper sulphate are dissolved in a gallon of water. This is applied with a large brush and allowed to dry thoroughly. Another method is to wash the surface with gasoline. It should be noted that no special preparation is necessary after the surface has been exposed to the weather for a year or two. In any case the surface to be painted must be perfectly clean.

Old Concrete Surfaces.—These simply require dusting with a stiff brush.

New Concrete Surfaces.—Surfaces less than a year old should be brushed over with a solution of 4 lbs. of Zinc Sulphate in one gallon of water. This treatment is used on new brick and plaster surfaces also. If there is a whitish coating on the brick—usually found below the windows—it will have to be removed by brushing with a solution consisting of one part of Hydrochloric Acid in five parts of water. After this treatment the wall must be well washed down to remove the acid.

Interior Plaster Walls.—If walls are new they will have to be treated with Zinc Sulphate as noted above, but after one year this will not be necessary.

If walls are dirty they will have to be washed. To do this prepare a warm solution in which some ivory or linseed oil soap is used along with a little washing soda, a handful of flour and some powdered glue, just enough to make the solution slightly sticky when rubbed between finger and thumb. Put this on one side wall with a whitewash brush and allow it to stand a couple of minutes. Now wash off the whole wall with clear warm water. Be careful to protect floor and baseboard or the dirty water may stain them.

Old wall paper may be removed by soaking it with a warm solution of very thin flour paste and when the paper is softened, scrape all off with a broad-bladed scraper. Then wash the whole wall with warm water containing some washing soda.

Large holes in the plaster should be cleaned out down to the lath, the edge of good plaster slightly undercut and the whole filled in with one of the prepared plasters. Dampen the edge of the hole and the lath before applying the new plaster. Cracks may be filled with a mixture of Plaster Paris and hydrated lime made into a putty by adding a little water.

Small cracks may be filled by making a white lead putty and working it into the cracks with a putty knife. This putty is made by using white lead paste with a little powdered whiting. If it gets too stiff, add a few drops of linseed oil.

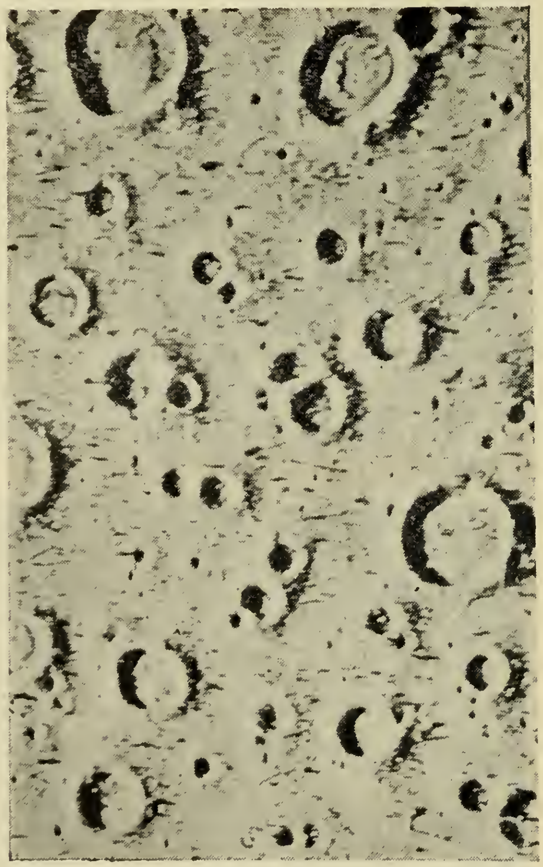
If walls are inclined to be porous a varnish size made of 1 part varnish to 1 part turpentine, to which a little of the paint has been added to offset the brown of the varnish, may be applied after the priming coat has been put on.

Walls to be calcimined are usually given a coat of glue size. This is made by soaking glue over night in enough water to cover it. In the morning this is heated to almost the boiling point and hot water is added. It should be made very thin.

Home Mixed vs. Factory Mixed Paints

When you have decided to paint, the question of mixing your own paint or of buying a factory product is bound to come up. Time and again you will hear people condemn a ready mixed paint. It should be understood that a reliable manufacturer, who has a reputation to keep up, can and will turn out a better product than you can make at home. This is especially true of paints for special purposes, as he has access to materials that the ordinary buyer cannot obtain. Furthermore it would be impossible to blend some of these paints at home. One of the advantages of a good mixed paint is that you can figure closer on any particular color whereas if you mix it yourself you will always have to make plenty for fear you would run short and have the difficulty of mixing and getting a good match.

You will pay more for a good mixed paint but in the long run it will prove the cheaper buy. While it is true that the package cost is invariably greater, the square-foot cost represented by the performance of the product is usually the same or less. For example, on actual experiments it has been found that a high quality paint will in every respect match the performance of a properly made lead and oil paint mixed by hand, but in addition will spread over a greater surface. In other cases tests have proved that one quart of a quality product made by machinery will go as far as two quarts of an improperly made or inferior paint,—so that on a square-foot basis, regardless of package cost, a high quality paint is invariably more economical.



Spotted effect produced by rain falling on a newly painted surface. (Enlarged)

No matter how good a mixed paint or any other paint is, if it is applied under unfavorable conditions of surface or weather, it should not be expected to give the service that it will when conditions are right. Dryness is a prime requisite and a temperature around 70°F is about right. Painting too soon after a rain will result in peeling and when rain falls on a freshly painted surface it will wash off some of the paint and give a spotted appearance.

Preparation of Ready Mixed Paints

1. Provide a clean empty can, a little larger than the one the paint is in. An old paint tin can be cleaned by taking it out of doors, pouring a little gasoline into it, sticking a wad of paper in and setting fire to the paper. Place the can on its side and roll it back and forwards as the paint burns. Wipe it out clean.
2. Open the can of paint and pour off almost all of the liquid into the clean can.
3. Stir the remaining paint with a smooth paddle until it is of even consistency and all is free from the sides and bottom of the can.
4. Add about a quarter of the liquid that you poured off and mix it until the consistency is even again.
5. Repeat this until the liquid has all been worked in.
6. Pour the paint back and forth from one can to the other several times.

As this paint is now of the right consistency for a final coat, you will have to thin it for the priming and second coats. If there are no directions on the can the following may be used.

For priming coat add 2/3 cup of Turpentine and 2 2/3 cups of linseed oil to each quart of mixed paint.

For the second coat add 1 cup Turpentine and ¼ cup of linseed oil to each quart.

Mixed paints for almost any special purpose may now be obtained and it is best not to use them for any purpose except for that for which they are specified.

Home-Mixed Paints

If you are going to mix your own paint it will be necessary to have some containers. Cans that can be made air-tight are excellent, as they keep hard films from forming on the paint.

Some smooth, strong wooden paddles for stirring are necessary.

A small screen with some cheese cloth for straining the paint through.

White lead of a good quality, pure raw linseed oil, pure turpentine and Japan drier are the principal ingredients used.

A good mixing procedure would be as follows:—

Measure and weigh out the ingredients according to the formula given later. This is very important and should be done carefully if you are to know where you are at.

Put the lead into a large container that has been wetted with some linseed oil. Add about a cup of oil and cut the oil into the lead with a paddle. Cut and stir the lead till all the oil has been worked in and you have an even paste. Add more oil and work it in as before. When about half of the oil has been worked in you should add the tinting material. This tinting material is usually in the form of an oil paste and a little of it should be mixed to a thin cream with a little turpentine. Add some of this to your white lead mixture and stir it in well. When all streaks have disappeared and if the color is strong enough test it out by putting a daub on a piece of clean glass. Examine the color from the other side. If the color is right, put this piece of glass away to dry and you can use it if you have to make a match of the same color. When all the tinting material is in, add the brown japan and the rest of the oil. Last of all work in the turpentine. Allow the batch to stand over night and strain through a thickness of cheese cloth placed over a piece of wire fly screen.

Standard White Lead Paints.

New Unpainted Wood Outside.

	1st Coat	2nd Coat	3rd Coat
White Lead Paste	120 lbs.	120 lbs.	120 lbs.
Pure Raw Linseed Oil	5 gals.	4 gals.	3 ½-4 ½ gals.
Pure Turpentine	1 gal.	¾ gal.	1 quart
Japan Drier	1 quart	1 ½ pints	1 ½ pints
Gallons produced	9 gallons	7 ¾ gals.	6 ¾-7 ¾ gals.

Old Painted Wood Outside.

White Lead Paste	120 lbs.	120 lbs.	120 lbs.
Pure Raw Linseed Oil	4 gals.	4 gals.	3 ½-4 ½ gals.
Pure Turpentine	1 gal.	¾ gal.	1 quart
Japan Drier	1 ½ pints	1 ½ pints	1 ½ pints
Gallons produced	8 gallons	7 ¾ gallons	6 ¾-7 ¾ gals.

New Wood Inside.

			Gloss	Flat
White Lead Paste	120 lbs.	60 lbs.	60 lbs.	60 lbs.
Zinc Oxide Paste	0	60 lbs.	60 lbs.	60 lbs.
Pure Raw Linseed Oil	1 gal.	1 ¾ gal.	3 ½ gals.	—
Pure Turpentine	3 gals.	1 ¾ gal.	1 ¼ gals.	2 ¾ gals.
Japan Drier	1 pint	1 pint	1 pint	¾ pint

Unpainted Plaster New.

White Lead Paste	120 lbs.	120 lbs.	....
Pure Boiled Linseed Oil	5 gals.	1 ½ gals.	....
Pure Turpentine	1 gal.	1 ½ gals.	....

Note:—In place of a white lead primer a Varnish size is often used.

Unpainted Plaster (new) 3rd Coat.

	Flat Finish	Egg Shell Finish	Gloss Finish
White Lead Paste	120 lbs.	120 lbs.	120 lbs.
Pure Boiled Oil	0	1 gal.	4 ½ gals.
Pure Turpentine	3 gals.	2 gals.	1 pint
Gallons produced	5 ½ gals.	5 ½ gals.	7 ½ gals.

Metal Work.

	1st Coat	2nd Coat	3rd Coat
Red Lead Powder	36 lbs.	34 lbs.	Same as for unpainted plaster under all conditions.
Raw Oil	⅔ gal.	⅔ gal.	
Boiled Oil	⅓ gal.	⅓ gal.	
Turpentine	½ pint	½ pint	
Lamp Black ground in oil	0	6 oz.	

Aluminum Finish on Metal

Aluminum Bronze	2 ¼ lbs.
Spar Varnish	7 pints
Turpentine	1 pint

Radiators for Steam and Hot Water.

Priming coat may be of Aluminum Bronze.
Next coat or coats as for New Wood (inside).
Never use Aluminum or Copper Bronze for a finishing coat as they will cut down the amount of heat radiated by from 15 to 25%.
White gloss enamel gives the best result.

Porch Floors, Waggons and Agricultural Implements.

	Priming Coat	2nd Coat	3rd Coat	
White Lead Paste	15 lbs.	11¼ lbs.	11¼ lbs.	
Zinc Oxide Paste	0	3¾ lbs.	3¾ lbs.	
Boiled Linseed Oil	1½ pints	0	3 pints	
Turpentine	4 pints	3 pints	¼ pint	mix first
Spar Varnish			1 pint	

Tinting color ground in oil added to 2nd and 3rd coats.

Shingle Stain.

Raw Linseed Oil	1 gal.
Coal-tar Creosote Oil	2 qts.
Japan Drier	1 qt.

Tinting color ground in oil added to this to get the desired color.

A cheap brown stain may be made by using black asphaltum varnish and thinning it with kerosene until you get the shade of brown you wish to use. Shingles are stained by brushing or dipping. The best way is to dip the shingles first and then give them a brush coat after the roof is finished.

To dip the shingles you will need a tub to hold the solution and a galvanized iron trough for draining them on. The drip from the shingles will run into the trough and back to the tub. Dip a number of shingles at a time into the stain for about two-thirds their length. Remove them immediately and stand them in the trough. When they have stopped dripping, scatter in a broad pile to dry before putting them on the roof. In working with stains containing creosote it is well to cover the skin of face, neck and arms with a thin coat of vaseline to prevent burning.

USING A PAINT BRUSH

As the final results in painting depend in part upon the way the paint is put on, a few pointers upon the application of paint are given.

The brush should be held with an easy grip in such a way that the tips of the fingers come about half way down on the ferrule. Hold the brush so that it is normally at right angles to the surface. This causes the brush to wear evenly. In painting a ceiling do not dip more than a quarter of the length of the bristles into the paint

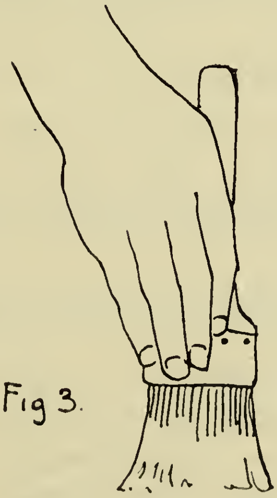


Fig 3.

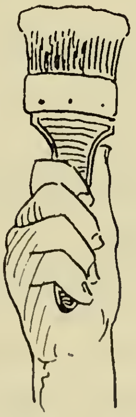


Fig.4.

Fig. 3. Holding the brush for average work.
Fig. 4. Holding the brush when painting ceilings.

and set the paint into the brush by slapping it against the inside of the can. Do not press too heavily and hold the brush entirely by the handle. Ordinarily start to lay the paint at the centre of the area you think the brushful will cover. Work the paint in with a rather circular sweep in one direction. "Lay off" by working it at right angles to this direction and finish with the empty brush in a direction parallel to the length of the strip you are painting. On ceilings take a strip about eighteen inches wide across the narrow length of the room.

On walls, start at the upper left hand corner and work in vertical strips about a foot wide. This allows you to get the second strip on while the first is still wet and so you avoid lapping streaks. When you come to a corridor, do the area above the window first, then a strip about six inches wide on each side of the window, bringing both sides down at the same rate alternately, after which you do the area beneath the window. As you finish a brush stroke do not flip the brush but bring it off gradually to avoid spattering. A clean cloth, very slightly dampened with a little turpentine, should always be at hand to wipe up spatters and drops.

Flat paints are harder to apply as they dry very rapidly and will roughen up if worked over or brushed too much. It is well to work rapidly on rather small areas and avoid all lapping.

FLOOR PAINTING

Paint as used for wood trim in a house will not stand up to the hard usage it would get when applied to a floor, so that it is necessary to modify the formula somewhat.

First Coat—This may be an ordinary white lead priming coat. When it is dry all holes and cracks should be puttied. For this purpose procure the very best putty and work into it about ten percent white lead paste. This mixture will give a good hard putty.

Second Coat—Same as for new inside woodwork.

Third Coat—Same as second coat but leave out the turpentine and put in a quart of floor varnish for every gallon of paint. Use only a real good varnish.

Always allow each coat to dry well, 48 hours is none too long and 72 hours would be better.

VARNISH

Varnished finishes are used a great deal but one often hears people object, as they say they are too glaring and shining. This gloss can easily be softened by rubbing it with a felt pad and using pumice and water. This, if carefully done, gives a beautiful soft lustre.

For best results in varishing the temperature should be around 70°F. and the room perfectly free from dust. The first coat may be brushed in a little more than the others. Varnish is always applied in thin coats lengthwise of the grain. If it does not set too rapidly, it may then be cross brushed and laid off lengthwise again into light, quick strokes. The first coat should stand a week before the second is applied, although it may appear quite hard after 24 hours. This hardness is really on the surface only. Before applying the second coat rub the first coat lightly with a number 00 sandpaper. Remove all dust with a "tacky cloth". This is a cloth that has a small amount of varnish squeezed out of it. It will pick up and hold the dust. The second coat may now be applied. Three coats will probably be enough. Sand all but the last coat.

WOOD FILLER

Before varnishing wood it is often filled. This is especially true of the more porous woods, such as oak, ash and chestnut.

To make Filler:—

Materials—12 parts of pure boiled linseed oil.
6 parts of brown Japan drier.
1 part of pure turpentine.

Mix these liquids thoroughly and work into them enough powdered Silex to make a stiff dough-like mass. Allow this to stand over night. Some of the oil will have come to the top and it should be well worked in. When you are ready to use the filler you will have to thin it with benzine or gasoline to a creamy consistency.

Applying Filler.—Use a fairly stiff brush and work it both with and across the grain, your object being to fill all the pores. Some workmen use a piece of inner tube pulled over a block of wood and with this they press the filler into the pores after brushing it on.

Removing Surplus Filler.—After the filler has lost its gloss (10 to 20 minutes), the surplus filler is rubbed off the surface. Use a 10-inch square of burlap or clean sacking and rub across the grain so as not to lift the filler out of the pores. Clean out corners with a pointed or chisel-shaped stick of wood. Wipe off any remaining filler with a clean cotton cloth. If any of it has become hardened, use a cloth dampened with benzine. Allow to dry for 24 hours and sand lightly with a fine sandpaper. Then dust off and you are ready to varnish.

VARNISH ON FURNITURE

For fine effects on furniture, the varnish should be rubbed between coats to remove any bumps, dust particles or thick spots. Use a 00 or 000 sandpaper which has been smoothed a little by rubbing two pieces of it face to face. Go over the hard varnished surface, working with the grain wherever possible and always finishing off with the grain. Dust off with a tacky cloth.

Apply the second coat and allow it to harden. This coat is rubbed with powdered pumice and water, using a thick piece of rubbing felt. Wet the felt pad and dip it into the pumice. Rub with the grain, just sufficiently to partly kill the gloss. It will be necessary to wipe off the pumice occasionally, in order to see that the rubbing is kept uniform. When a uniform dullness has been secured, clean off and dry the surface.

The last coat when thoroughly dried is rubbed with FF pumice as before and when it has been cleaned off, it is given a final rub with a polish made by mixing 1 quart of vinegar, ½ pint of 3 in 1 oil and ½ lb. rotten stone. Shake this well and rub with a circular motion. Clean off with a dry, soft cloth.

STAINING WOODS

Stains are classed as Oil stains, Spirit stains and Water stains. The beginner will find the oil stains easiest to apply, as they do not become blotchy if you lap back on to a previously stained part.

Wood to be stained must be perfectly clean and smooth and the stain applied rapidly with strokes the full length of the piece if possible. Do the least seen parts first. Work from top to bottom. Wipe up all surplus stain with a clean cloth.

If a water stain is to be used, it will be necessary to raise the grain of the wood first. This is done by sponging the surface with clean water and a sponge, just enough to dampen it. Allow it to dry and then sand off the fuzz that rises up. The surface will have to be covered very rapidly to make sure that there will be no streakiness. If there is any tendency for stain to lie on the surface, pick it off very quickly with the brush, having first rubbed the brush firmly on the edge of the pail or over a paddle to render it partially dry. Speed and lightness of touch are essential.

LACQUERS

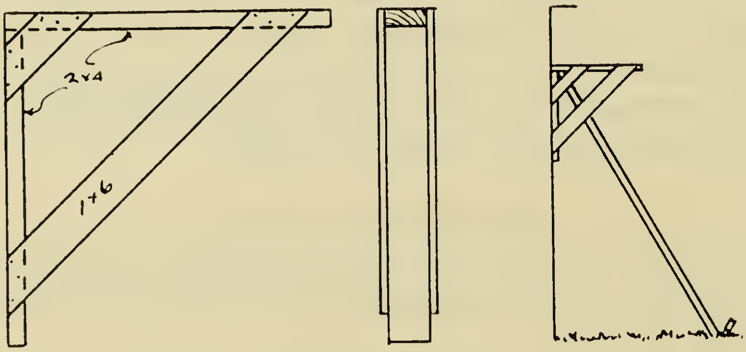
Modern finishes have been developed since the war that are remarkable for their quick-drying properties. They should be applied to the raw wood or over shellac. Subsequent failure almost invariably happens if this rule is not observed. In applying lacquers use a soft brush and allow about three hours between coats.

Some of the best known colored varnishes may be used in place of lacquer.

SCAFFOLDING

The amount of scaffolding needed is generally determined by the number of men doing the job. Often all that is needed is a ladder or a step-ladder.

A simple type of scaffolding is that in which a right angle bracket is held against the wall by a good brace.



Angle brace.

Another type is made as illustrated in Fig. 6.

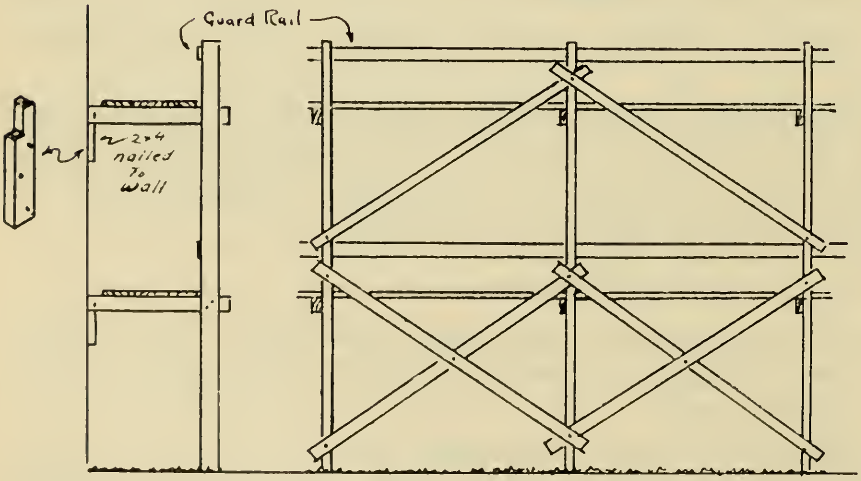


Fig. 6

Scaffolding secured to building at each stage.

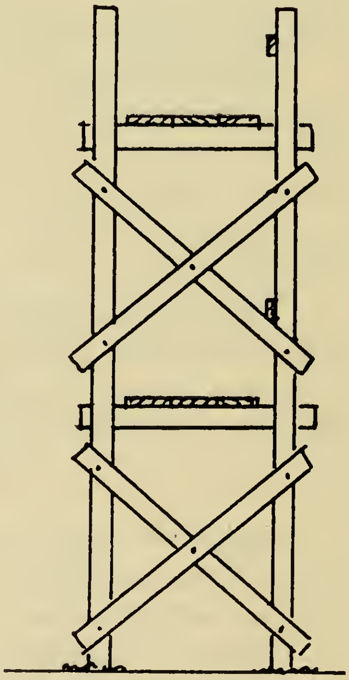


Fig. 7.

Scaffolding independent of building for support.

These units are then braced as in Fig. 6.

Scaffolds must be built in such a way as to give the worker confidence in them if he is going to do a good job.

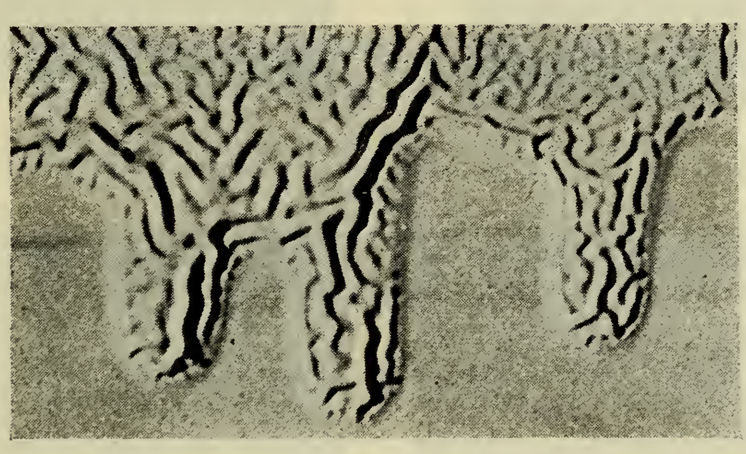
A third type is made by constructing units of two posts with joints and braces. These are constructed on the ground, raised to place and fastened to the building.

SOME COMMON PAINT TROUBLES

1. *Chalking.*—This is not considered a serious defect, unless it is so bad that it rubs off on the clothes for example. Chalking in moderation is desirable in that it gives an excellent surface for repainting jobs.

Causes:—Probably not enough oil has been used in the priming coat and the wood has absorbed all of it, not leaving enough on the surface to oxidize and form a film to hold the white lead in place. Too much oil must be avoided, of course, and this gives the best of all reasons why one should measure and weigh all the materials used and follow the formulae as given.

2. *Slow Drying.*—Slow drying may be caused by painting when weather conditions are not favorable, but usually this is due to the use of inferior oils or old oils that have become thick or syrupy. Oil from the bottom of the tank containing sediment called "foots" will also be slow drying. Cold, non-absorbent or damp surfaces tend to slow up drying of paint.

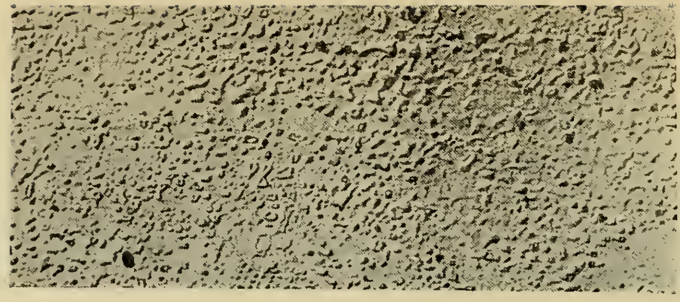


Sagging of paint. The wrinkled film will not wear well.

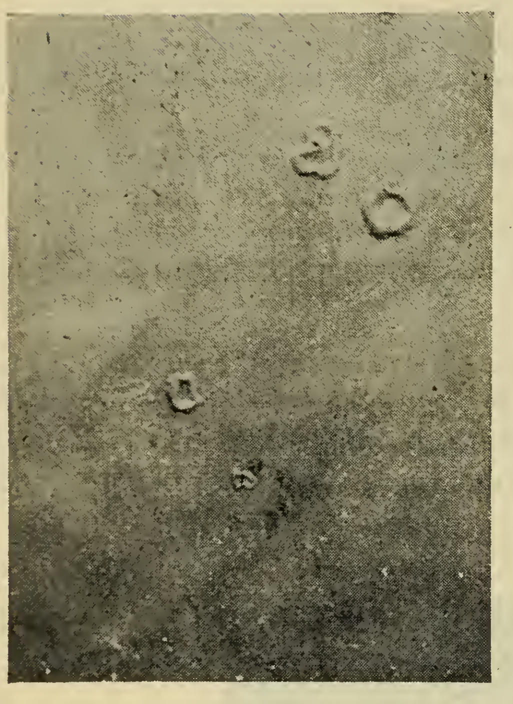
3. *Runs and Sags.*—These may be caused by applying paint too thickly or by using a slow drying paint. Painting over a glossy surface will also result in runs. It is well to kill the gloss by sanding it lightly and then dusting it off.

4. *Loss of Gloss.*—Many people are disappointed when after a few months they notice that the paint has lost the gloss. This is a natural result of the aging of the paint. If it has taken place in spots only then it may have been caused by painting over surfaces that are more porous than the adjoining surfaces. It may be noticed on plaster walls over cracks that have been filled with Plaster Paris or over areas that have been sanded.

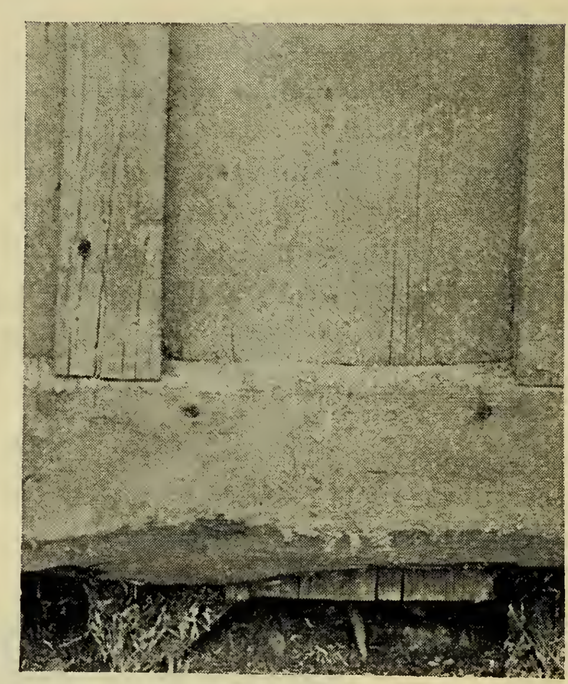
5. *Yellowing of White Paint Indoors.*—Linseed oil, which is yellow, will not bleach unless exposed to sunlight, so that a minimum amount of oil is generally used for indoor painting and if a gloss is desired it is best gained by using white enamel paints.



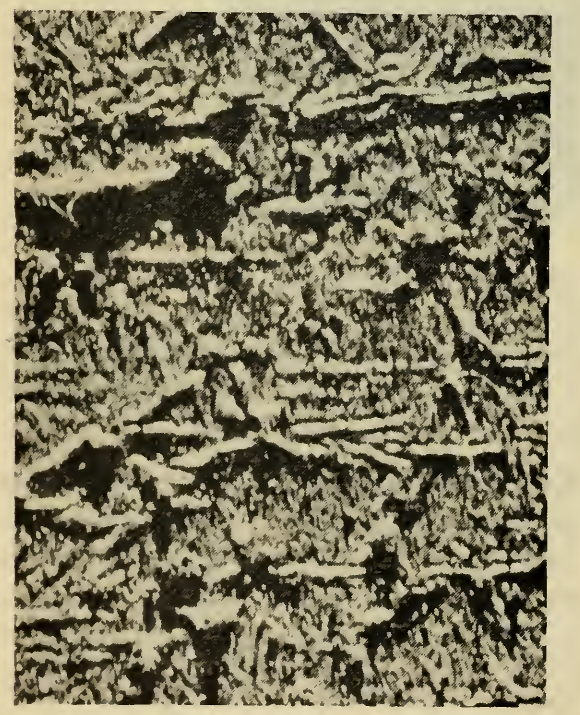
Blistering caused by heat.



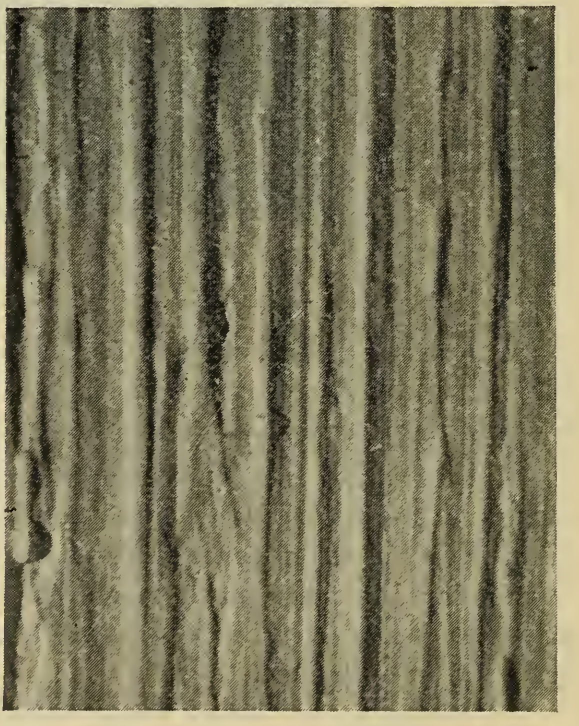
Blistering of paint on moist wood.



Peeling of paint where it is on wood that is in contact with dampness.



Result of painting under dusty and freezing conditions.



Brush Marks. A paint film is no stronger than its thinnest part and best results cannot be obtained unless the paint is brushed out evenly with a good brush.

6. *Cracking.*—This is a defect extending right down to the wood. It is often accompanied by scaling and is especially noticeable where coat after coat of paint has been added until an excessive thickness has piled up. Another cause may lie in the use of insufficiently seasoned woods. These gradually contract and cause cracks in the paint film.

7. *Checking.*—Unlike cracking this is a surface trouble and may present a fine or a coarse appearance. It lies in the top of the paint film and does not extend to the wood. It is often seen to effect on furniture that has been lacquered over an older varnished or painted surface. It will also happen when paint has been applied over coats that are not sufficiently dry. Inferior materials may be another cause.

8. *Blistering and Peeling.*—Blistering and peeling of paint are caused by moisture or heat and may be found on both wood and metal surfaces. Strong sun shining on paints that are too rich in oil will cause blisters and it is a common thing to see blisters on woodwork that is very close to a hot stove.

Oil or grease left on a surface that is to be painted will cause blistering.

The most common cause of this trouble is to be found in water that is on the surface or in the pores of the wood. If in the wood it may be sap or water that has been absorbed from some outside source. Wood should be well seasoned before it receives other than the priming coat. On the surface it is usually due to rain, melting snow or frost. Painting, when this condition is present, will result in peeling.

PAINTING THE HOUSE OUTSIDE

1. Estimate area to be painted. Decide on colors.
2. Calculate amount of paint required.
3. Procure or make the paint.
4. Go over the surface, scrape off all loose paint thoroughly, then sand the rough places. Slightly sand all the surface at the same time. Dust off, especially in corners.
5. Replace rotten or broken parts and shellac any knots that have been exposed in the scraping.
6. Go over the windows carefully. All putty should be replaced if loose or missing.
7. Apply coat of priming paint (rather rich in oil) to all scraped portions and new sections.
8. Go over the building, filling all holes with putty. This should be a white lead putty.
9. Apply coat to all surfaces, brushing it well into the wood, working from the peak of the house towards the eaves and from the eaves to base.

INSIDE PAINTING

New work, built in cupboards — enamel finish.

1. When carpenter has finished, go over all surfaces with sandpaper if he has not done so.
2. Shellac all knots and sappy places.
3. Apply priming coat.
4. Putty all nail holes, cracks, etc., with a white lead putty.
5. When quite dry, sand lightly and dust off.
6. Apply 2nd coat. This is a flat coat. Sand lightly when dry.

7. Apply 3rd coat, to which an equal amount of enamel has been added.
8. Sand lightly when dry or rub with pumice powder and water on a felt pad.
9. Dust or clean up thoroughly.
10. Apply enamel as it comes from can.
11. If you wish, rub with finest pumice and water on a felt pad.
12. Clean up thoroughly.
13. Polish with rotten stone and oil.
14. Wipe up with clean dry cloth.

Note:—The last four steps are only carried out when an extra fine finish is required.

The inside of cupboards for pots and pans may be lined with scrap linoleum tacked to bottom and vertical sides. They may also be finished by giving a coat of orange shellac. When this is perfectly dry—over night—they may be varnished with a good tough floor varnish.

Re-varnishing a Worn Floor

When a varnished floor has worn through to the wood in places where it receives hard usage, the worn spots must be attended to first.

1. Wash the floor perfectly clean being careful to rinse it thoroughly.
2. Treat the worn places with a solution of oxalic acid and water—equal parts of each.
3. Rinse thoroughly with clean water.
4. When dry the grain will appear raised slightly and it will have to be sanded to a smooth surface.
5. Sand the old varnished surface to kill the gloss.
6. Wipe up dust with a "tacky" cloth.
7. Varnish the worn spots with a good tough floor varnish.
8. Dry for 48 hours at least, longer if possible.
9. Varnish the whole floor with the same varnish.

Note:—Temperature of room should be about 70°. There should be no dust around.

If very badly worn it may be advisable to remove all the old varnish. Use a good varnish remover and scrape down to the wood. Clean up with benzine and remove stains with the oxalic acid. Rinse, sand and varnish as above.

Re-finishing a Chair

Occasionally you may wish to refinish such an article. If the surface is not in bad condition, proceed as follows:—

1. Wash thoroughly with a strong solution of washing soda to remove all grease.
2. Sand all rough spots until smooth with a number 0 sandpaper.
3. Lightly sand the whole article.
4. Dust off with a "tacky" cloth.
5. Refinish with a colored varnish.

If the surface is in bad condition you had better remove the old finish with a paint or varnish remover. This material is painted over the whole article. The old paint becomes soft and may be scraped off with an old dinner or putty knife. Clean out all corners carefully, then wash with benzine, after which the article may be painted or varnished as in new work.

WAXING FLOORS

Before rewaxing a floor go over it and clean off all dirty spots with a soft cloth dampened with benzine. It may not be necessary to touch up more than a few spots but it saves your polishing cloth from becoming excessively dirty. The whole floor should be dusted with a dust mop before attempting to apply the wax.

Use a good grade of wax. Place a lump of the floor wax in two or three thicknesses of cheese cloth and as you rub this over the floor a thin even layer of wax is left on the wood. Allow this to stand for about 15 minutes before polishing. If you try to polish much before this time you will remove a lot of the wax and if you leave it on for a long time without polishing you will find the job more difficult.

A clean soft piece of flannel-like cloth may be used for polishing and a brisk rubbing will soon result in a bright surface being produced.

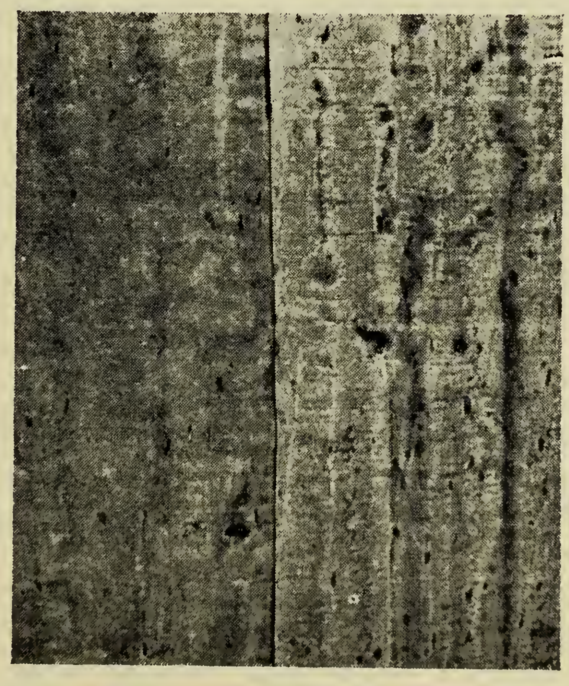
To prevent worn spots appearing in the floor you should anticipate them by applying a protecting coat of wax on the places that receive the hardest use, about once a week.

All inlaid and plain linoleum can be given a coat of good paste wax as soon as laid. Afterwards you may use the liquid waxes for touching up the parts receiving the most wear.

Water should be wiped off a wax surface at once. If allowed to remain it will spot the finish.

PAINTING A GALVANIZED ROOF

Galvanized roofs should be inspected twice a year for the first sign of rusting. This is indicated by a yellowish or reddish brown discoloration. It is high time to paint when this appears. Look for nails that are coming out, withdraw them and put in larger ones to get a fresh hold in the wood. Points of these nails are best if barbed. Use the heavily galvanized type of nail with large head. See that the metal is down tightly at every point. Line up the eave troughs and clean out any dirt that may be in them. Procure a stiff wire brush something like a scrubbing brush, and clean every particle of rust off. The surface must be clean and dry.



Galvanized iron with the first stages of rust beginning to show.

The paint used may be made as outlined for metal painting or a reliable brand of ready made paint having red iron oxide as a base may be used. This paint must on no account be thinned with kerosene or gasoline.

The priming coat should always be put on with the greatest care. It is the foundation upon which the structure rests. Work the paint well into the joints. The last coat may be of some light color, so as to keep a more even temperature inside of the building.

Note:—Paint will not remain for more than a short time if it is applied to new galvanized iron unless the surface is treated first. Dissolve four ounces of copper sulphate in a gallon of water and apply to the surface to be painted when this has dried you will find that the surface has become roughened and there is a thin deposit of copper on it. After about an hour lightly brush off the surface and rinse with clean water. When the surface is dry you may proceed with the painting.

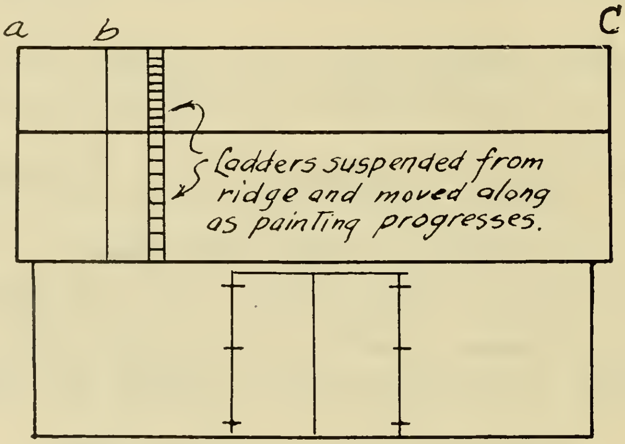

a
b
C
Ladders suspended from ridge and moved along as painting progresses.

Fig. 8.

This shows ladders suspended from ridge.

Ladders may be suspended from the ridge as shown in Fig. 8. Start work at "a" and paint about ten feet to "b". Start again at "c" and work back towards "b". By the time you reach "b" the section "a" to "b" will be dry and the ladders may be placed on it while finishing.

COLOR SELECTION

In the selection of colors we must bear in mind the fact that all colors will be affected by the colors immediately surrounding them so that often we find that we have produced an effect that we had no intention of producing. This leads us to consider a few elementary principles in color harmony and contrast, some of which may be stated as follows.

1. A lighter shade appears lighter and a darker shade appears darker if the two are placed side by side.

2. The following pairs of colors when brought together will intensify each other and when a large quantity of one is mixed with a small quantity of the other will produce a gray of the predominating color.

Red and Green.
Blue and Orange.
Yellow and Purple.

3. Colors that are excessively bright, when brought together intensify each other and become inharmonious and unpleasant.

4. A trim color that is darker than the body color has the effect of making a house look smaller. A trim color that is lighter than the body color will make the house look larger. Large houses may well be dark in color and small houses light in color.

One can secure a harmony by using different tones of the same color as varying shades of brown or varying shades of green. If however contrasting colors are desired it will be well to have both colors considerably grayed. How to do this is given in the section on color theory.

Nature spreads a mantel of green around our homes and by using varying tones of green we can secure harmony. White, browns and greenish grays also harmonize with nature's green. Stronger and brighter hues may be used as accents in the trim or the window sash.

Avoid spotty effects, such as one so often sees where there is an attempt at originality without the possession of an artistic sense. Plain elegance is a good rule in all things. Such colors as pink, cherry-red, vermillion and dark blue are not appropriate for outdoor use and in addition are not lasting. In place of them you should use cream, ivory, colonial yellow, light buff, cream gray, etc.

Inside of the house we may use more freedom in our selection and adapt the color to the general atmosphere of the room. For example—hall and living room should have soft dull colors as light yellows, greens, blues, browns and grays. Tiffany blends with grey green as the predominant color are very restful. For bedrooms, the more dainty and delicate hues such as mauve, lavender, rose, pale blues, etc., may be used. In den or dining room we can use stronger and richer colors in greens, blues, browns and some dark reds.

We should always take into consideration the exposure or situation of the room. The darker the room, the lighter may be the color used and in rooms receiving plenty of light we may use the darker colors. Northern exposures demand warm colors such as cream, tan, buff, golden brown, etc., while those facing south may have the cool greens, blues and gray browns.

Unless a room is so situated that it is markedly cut off from the rest of the house, we should aim to have it harmonize with the general scheme. To do this the color in each room must have something in common with its neighbors.

In the small house the wall papers should be subdued both in color and design and painted walls should be light tinted.

When we come to consider buildings other than the house we often find that people will throw all rules of good taste to the winds and put on the cheapest red paint that they can buy. Not only are some of these reds unpleasant to look at but they are not durable, neither do they leave a good surface for repainting.

We paint to protect the building of course but there is no good reason why we should neglect the principles of good taste. Barns and other buildings should harmonize with the house and with the green of nature. Cream, gray or soft green tones are always pleasing.

A few color suggestions for exterior painting.

Body	*Trim*	*Sash*
Pure white.	Olive Green	Black or a darker green.
Cream	Light Brown	Sage Green
Leather Brown	Cream	Moss Green
Colonial Yellow	White	White
Chocolate Brown	White	White
Gray (neutral)	White	Dark Green
Cream Gray.	Moss Green	Ivory
Ivory	Moss Green	White

For those who wish a more extended knowledge of color a section on Color theory is given.

COLOR THEORY

Where a number of colors are to be used together their relation becomes a problem of great importance. There are many people with a natural sense for color who will instinctively pick out the correct combinations. Most people would have to trust to the judgment of another or else make a study of the subject. A little knowledge of the theory of color is often a great help and anyone who is willing to put a little time on the subject will be amply rewarded.

Certain terms used in connection with color are:—

1. *Hue*—Hue is the quality by which we distinguish one color from another, as red from blue.

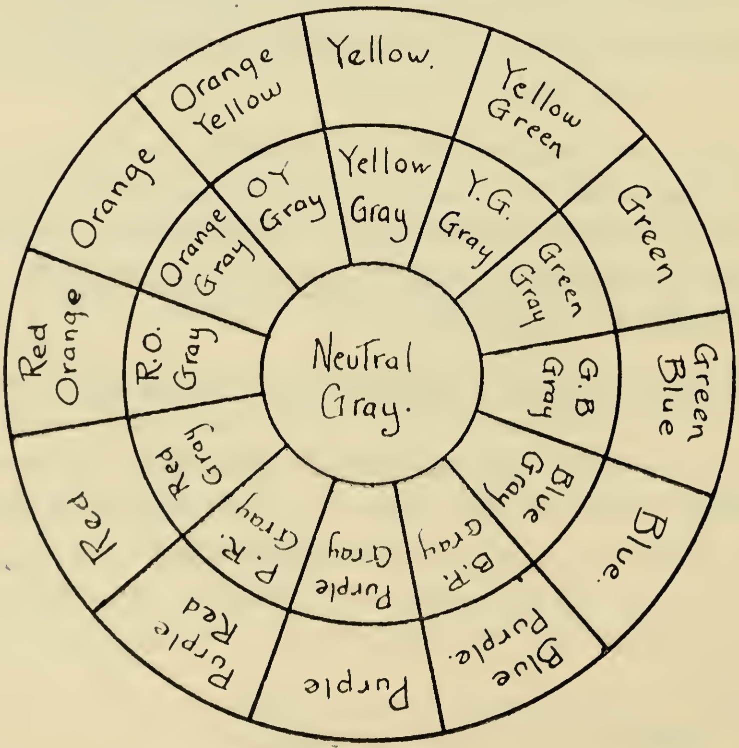
2. *Value*—Value is the quality by which we distinguish a light color from a dark one.

Tints are produced by adding a color to white.

Shades are produced by adding black to a color or to white.

3. *Chroma or Intensity* is the quality by which we distinguish a strong color from a weak one, as red from gray red.

A simple plan to follow in the study of color is by the construction of color wheels. These are divided into parts and each part is colored by the use of water colors. Three colors only are necessary. These are red, yellow and blue.



Color Wheel.

Draw a circle about 4 inches in diameter and divide it into equal parts as shown in the diagram (Fig. 9). Paint the top space with a pure yellow. Skip three spaces to the left of the circle and fill in with a pure clear red. Skip three more and put in a pure blue. These colors are called the Primary colors because with them we can produce any other colors.

If to the red we add a little yellow, we have a yellowish red. Add a little more yellow and we have a red orange. Add a little more and we have a pure orange. Adding still more will give us a yellow orange. In a similar way we might work backwards to produce a reddish yellow by adding a little red to a pure yellow and eventually arrive at orange.

We can in this way produce another set of colors called Secondaries by combination of two primaries as follows:—

Red and Yellow give Orange.
Yellow and Blue give Green.
Blue and Red give Purple.

These colors should be mixed and placed in their proper places in the wheel.

During this mixing we have produced certain colors that lie between the primaries and secondaries, namely, yellow green, green blue, blue purple, purple red, red orange and orange yellow. These colors should be made very carefully and placed in their proper places in the wheel.

If we look at these colors we will see that we have a grading in brightness from yellow at the top around to purple at the bottom. There is also a very important grading in warmth from orange, the warmest, around to blue, the coolest.

Warmth in color often becomes a very important question. We do not want a great many of the warm colors in a room that has a warm southern exposure for example.

Usually, however, we aim at a balance between the warm and the cool colors and in our wheel this balance is obtained by colors directly opposite on the circle. These opposite colors are said to be complementary, the one to the other and they are perfect contrasts. For example, orange is the complement of blue, red the complement of green.

Grayed Colors.

If we mix any two complementaries carefully we can produce a perfect gray in which neither of the complementaries can be distinguished. This should be done and the centre of the color wheel filled in. As this gray shows no signs of yellow, red or blue we call it a neutral gray.

We can produce a gray of any hue by mixing with that hue a slight amount of the complementary. This grayed color is always less intense than the original hue. We must now attempt to fill in the remaining sections on our wheel with grayed colors, trying to produce a color about half as intense as the original color. For example, by adding a very little purple to yellow we reduce the intensity of the yellow. If we add more than we should we may get a neutral gray. Our object then will be to produce a yellow gray that is half way between a pure yellow and a neutral gray. Do this with each color until the spaces are all filled. We are now ready to use our wheel in the study of color harmony.

In the theory of color three types of harmony are recognized, Monochromatic harmony, Analogous harmony and Complementary harmony.

1. *Monochromatic* or one color harmonies are produced by selecting a certain color as a predominating color and the colors to go with it and then made by adding

black or white in varying amounts to the original color. For example with yellow we might have creams and ivories.

2. Analogous or related color harmonies are obtained by using the colors that are closely grouped on the color wheel. To see this better, cut out a disk to cover the color wheel. Then from this disk cut out a section equal to a quarter of the whole. Place this over the original color wheel and those colors that remain uncovered form an analogous harmony. (Fig. 10).

3. *Complementary* harmonies are produced by a balance of opposite colors.

Ordinary complementary harmonies may be shown at a glance by constructing a disk as before, but in this case remove two pieces at opposite sides of the disk and to uncover a single section on each side. (Fig. 11).

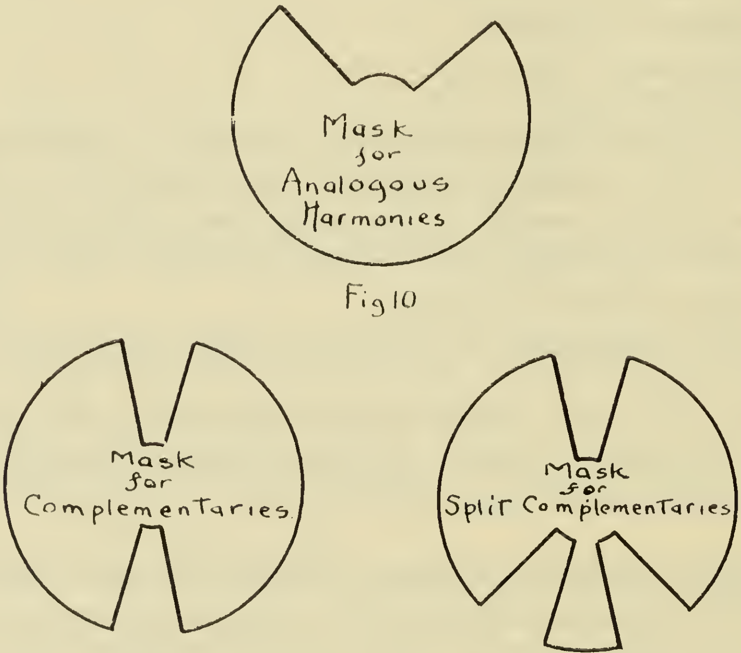


Fig 10

Fig. 11

Fig. 12

Masks.

What are known as split complementaries are shown by means of a disk cut to show a color and two opposing colors, leaving out the exact complementary. Fig. 12).

If you decide on a certain predominating hue you can now pick out harmonious colors to go with it by use of the disks placed over the wheel and exposing the desired predominant. It is always wise to work with the grayed colors in the larger areas on any job getting the accents by use of the more intense colors. This is an extremely important rule to remember.

Certain points that should be kept in mind when handling color schemes may be summarized as follows:—

The colors bordering on blue or gray give a cool feeling and tend to make rooms appear larger. Orange tints are used in connection with them but only in small proportions and they add a note of cheer. If two complementary colors are placed side by side they emphasize each other and should not be used to cover large areas.

In room decoration aim to have a grading in value from light to dark, the ceiling being the lightest. If the floor should happen to be of a light character the rugs should be darker to carry out this idea.

Black Acid Proof Stain for Laboratory Table Tops

Solution "A"	
Iron Sulphate	40 g.
Copper Sulphate	40 g.
Potassium permanganate	80 g.
Water	1000 c.c.

Solution "B"	
Analine	120 g.
Hydrochloric Acid	180 c.c.
Water	1000 c.c.

Directions for Use.

Two coats of Solution "A" are applied hot, by means of a brush. The second one is put on as soon as the first is dry. Excess of the solution which has dried on the surface of the wood is thoroughly rubbed off.

Two coats of Solution "B" are next applied and the table top allowed to dry thoroughly.

Last of all a coat of linseed oil is applied with a cloth in order to avoid excess oil.

The Black color will not appear at once but develops gradually.

At the end of a term the table should receive a thorough washing with soap and water. When dry it should be given a coat of linseed oil applied with a cloth in order ot keep it thin.

Strong acids or alkalies should be wiped up as soon as spilled.

WHITEWASHES FOR FARM USE

Whitewash has a wide application to farm use and deserves a much greater popularity than it at present enjoys. Its ingredients are inexpensive and readily obtained; it is not difficult to make and it is easy to apply it. In addition to these advantages, it protects the surfaces to which it is applied, brightens up dark interiors and is sanitary. A fact not generally known is that whitewash may be coloured provided that light tints and shades are used and that the pigments are not affected by lime. Among such are yellow ochre, raw and burnt amber and raw and burnt sienna.

Preparation of the Surface.—The surface to be whitewashed should be just as clean as one that is to be painted and it is a first essential to good results that all dirt, dust, grease and scaley material be removed before there is any attempt to apply the wash. This implies a liberal use of scrapers and stiff brushes. When the cleaning is finished and the surface dusted , it is well to dampen it slightly just before applying the wash.

Application of Whitewash.—Whitewash may be applied with the brush or sprayer. In applying with the brush use one at least four inches wide and work rapidly making no attempt to "brush out" as in painting. Let the coat be fairly thin and transparent and it will be opaque when dry. The small hand sprayers sold by the seed firms may be used. These will cost around $10 and should be of brass if you expect them to last for a number of years. In using sprayers it is quite necessary that the wash be strained through at least two thicknesses of cheese cloth. Spraying has many advantages over brushing under certain conditions and it forces the material into cracks and crevices that would not be reached by the brush. In using the sprayer always hold the nozzle so that the wash is applied at right angles to the surface; this gives even application. The sprayer should be thoroughly cleaned after use and especially the nozzles as a small particle of dirt clogging one side of the nozzle will cause it to send out a lop-sided stream and the work will be patchy.

Estimating Quantities.—In estimating the quantity of material required many problems and conditions are encountered, but the following general figures may be used as a basis. One gallon of whitewash will cover approximately 225 square feet of wood, 180 square feet of brick and 270 square feet of plaster. Using a 4-inch brush a man will cover 200 square feet of ceiling, 200 square feet of rough wall or 350 square feet of smooth wall in one hour.

EXAMPLE.—Basement 36' wide x 60' long x 9' high.

Distance around walls is 192 feet.
Area of wall is 192'x 9'=1,728 square feet.
Area of ceiling is 60'x 36'=2,160 square feet.
Total area ....=3,888 square feet.
225 square feet require 1 gallon.
3,888 square feet require 3,888 divided by 225=18 gals. approximately.
200 square feet are covered in 1 hour.
3,888 square feet are covered in 20 hours.

Notes on the Preparation of Whitewash

(*a*) Prepare the lime and water paste a few days before you wish to use it.

(*b*) Where casein, glue or formaldehyde are to be used, the solutions must be brought together only when they are *quite cold.* This is very important.

(*c*) The solutions mention in (*b*) should be added *quite slowly* and at the same time they should be stirred vigorously and constantly.

(*d*) In no case should you mix more of the wash in one day than you can use in that day when any of the solutions mentioned in (*b*) are used.

(*e*) Skim milk may be used as a substitute for casein but it is not quite so effective.

(*f*) In place of one sack (fifty pounds) of hydrated lime, you may use the paste made by slaking one-half bushel (thirty-eight pounds) of fresh quick-lime with about six gallons of water. This slaking is sometimes done by placing the quick-lime in a barrel and adding the water boiling hot. If cold water is used the water may be added a little at a time stirring each time; when heat ceases to be given off the lime is slaked.

Before using, strain this paste through a fine screen.

(*g*) Molasses is said to render the lime more soluble and to give it greater penetrating power. Use in proportion of one pint of molasses to five gallons of the wash.

(*h*) Alum tends to prevent rubbing and is used in proportion of one ounce to one gallon of the wash. It would not be needed in the formulae C, D or E given below.

(*i*) If a gloss is desired, dissolve one pound of bar soap in a gallon of boiling water and when it is cold add it to five gallons of the thick wash.

Some Common Formulae

A. 1. Dissolve fifteen pounds of common salt in seven and one-half gallons of water.
2. *Slowly* add one sack of hydrated lime, *stirring vigorously.*
3. Thin this to a milk like consistency with water.

B. 1. Make a paste of one sack of hydrated lime and seven gallons of water.
2. Dissolve one pound of common salt and one-half pound of zinc sulphate in one gallon of boiling water. Allow this to cool.
3. Pour this last solution into the lime paste solution a little at a time, stirring vigorously.
4. Stir in two gallons of skim milk.

C. 1. Soak five pounds of casein in two gallons of hot water for two hours.
2. Dissolve three pounds of trisodium phosphate in one gallon of water.
3. Mix these two and allow the casein to dissolve and cool.
4. Make a cream of one sack of hydrated lime and seven gallons of water.
5. *Slowly* add 3 to 4, stirring vigorously.
6. Just before using, dissolve three pints of formaldehyde in three gallons of water and add it *very slowly* to 5, stirring vigorously. Do not mix more than can be used in one day.

D. 1. Soak five pounds of casein in two gallons of hot water for two hours.
2. Add three pints of household ammonia to one gallon of water.
3. *When cold,* mix 1 and 2.
4. Make a cream of one sack of hydrated lime and seven gallons of water.
5. *Slowly* add 3 to 4, stirring vigorously.
6. Just before using, dissolve five pints of formaldehyde in three gallons of water and add it *very slowly* to (5), stirring vigorously.
7. Thin to a milk-like consistency.

E. 1. Dissolve three pounds of glue in two gallons of hot water and allow to *cool.*
2. Make a cream of one sack of hydrated lime and seven gallons of water.
3. Mix (1) and (2), stirring vigorously.
4. Thin to a milk-like consistency.

F. 1. Make a cream of one sack of hydrated lime and eight gallons of water.
2. Slowly add one quart of crude carbolic acid, stirring vigorously. The quantity of acid may be doubled, if desired.
3. Thin to a milk-like consistency.

G. 1. Make a cream of one sack of hydrated lime and seven gallons of water.
2. Dissolve six pounds of salt in three gallons of boiling water.
3. Mix (1) and (2) when cold.
4. Stir three pounds of Portland cement into (3).

Uses for the Different Formulae

Formula A. and B. Unimportant outdoor work, sheds, fences and trees.
" C. and G. Higher grade of work on dairies, buildings and trees.
" D. Basements that tend to be damp.
" E. Dry basements.
" F. As a disinfectant wash but liable to rub.

BULLETIN No. 342] [APRIL, 1929

Ontario Department of Agriculture
ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

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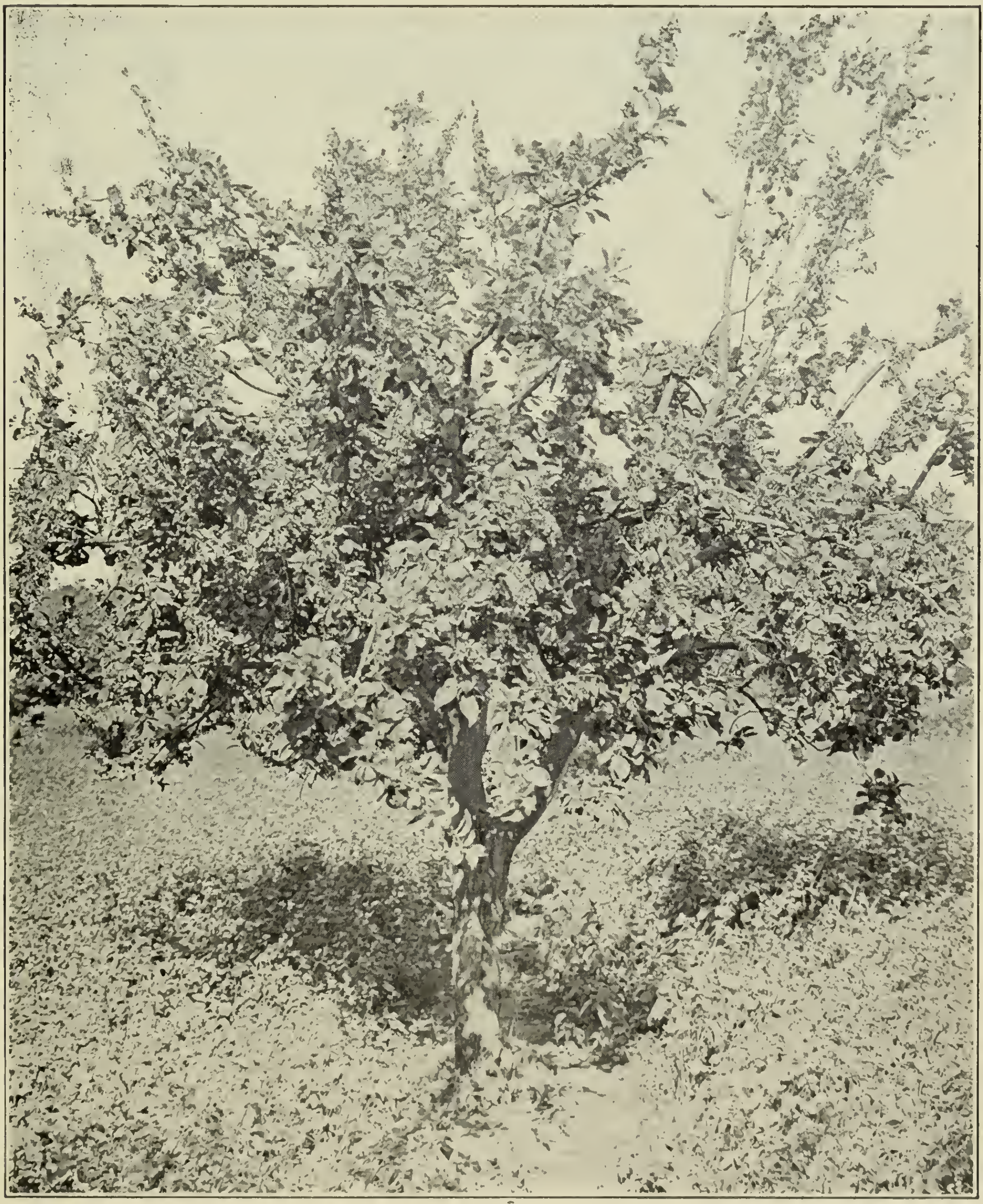
Fire Blight and Its Eradication

By Professor D. H. Jones, *Bacteriological Department*



Mature apple tree (Romenskœ) badly affected with fire blight.

INTRODUCTION

Twenty years ago, on making an extended investigation concerning the prevalence of fire blight in the Ontario fruit districts, we found that many pear orchards and quince plantations had been completely killed out by it and every year a heavy toll was taken from many apple orchards by its ravages.

In Bulletin 176, "Bacterial Blight of Apple, Pear and Quince Trees," published by the Ontario Department of Agriculture in 1909, we gave an account of the investigation, a full description of the disease, the methods by which it is spread, and measures for its control. For the latter, we advocated the cutting out of all diseased parts from the trees, extreme care being taken to cut well below the visibly affected areas, and the immediate burning of all parts cut away, as being the only satisfactory means of eradication.

Wherever this policy has been efficiently carried out, the disease has been controlled. It has sometimes taken two or three years to completely eradicate the disease from an orchard, and some years when there has been a bad epidemic, more particularly of blossom and twig infection in any particular district, it has seemed an almost hopeless task to cut out all diseased parts of the trees. In such cases, however, it should be borne in mind that the case is not so hopeless as it looks, but that where the disease does not pass from the infected twigs into the larger branches it is apt to die out before the following season. *Where, however, it passes from infected twigs, watersprouts and suckers into the larger limbs or trunks, it is liable to winter over and start again the following season.* It is such cases that should be carefully looked for and every care taken to cut them out before the following spring, *as they alone are responsible for the primary infections that start epidemics.*

A survey of the fruit district during last season, 1928, revealed the smallest amount of fire blight that we have seen any year for twenty years. *If we bear in mind that every season's outbreak of fire blight starts from hold over cankers from the season before, and that providing we cut out such cases of the disease before the growing season starts we shall prevent recurrence of the disease, we shall realize that the present season offers a splendid opportunity for stamping out the disease because there were so few cases in evidence during last season.* Hence, if apple, pear and quince growers will carefully scrutinize their trees and efficiently cut away the relatively few blight cankers left from last year, we shall have a good clean up of this disease which for more than a hundred years has been one of the worst and most costly pests of pome fruits on the North American continent.

PLANTS SUBJECT TO THE DISEASE: Apple, pear and quince trees are the commercial fruits mainly affected, though a very few cases are on record of light infestation on plum, cherry, prune, apricot, loquat (*Eriobotria*) and medlar (*Mespilus*). Among wild or ornamental trees and shrubs it attacks hawthorn (*Crataegus spp.*), juneberry or serviceberry (*Amelanchier*), wild crab (*Malus*), mountain ash (*Sorbus*), and the red berried California holly (*Heteromeles arbutifolia*).

GEOGRAPHIC DISTRIBUTION: Fire blight was first noticed in the Hudson River valley of New York State, over a hundred years ago. From there it quickly spread to other parts of the state and into the southern parts of Ontario. Since then it has spread to every apple and pear growing state in the Union and every province of Canada. Until recent years it was confined to the North American continent, but in 1911 it was reported as being established in Japan. In 1919 it was reported as spreading rapidly in the Northern Island of New Zealand, and in 1924 a severe outbreak on pear trees was reported from Italy.

CAUSE OF THE DISEASE: Fire blight, also known as blossom blight, blight canker and bacterial blight of apple, pear and quince trees, is a bacterial disease caused by *Erwinia amylovora* (*Bacillus amylovorus*) Burrill, Trevisan, Com. S.A. B., gaining entrance to the living bark tissues causing the invaded area to canker and die.

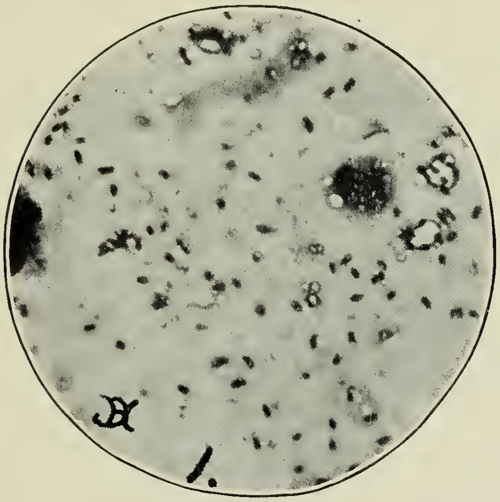


Fig. 1. **Erwinia amylovora** (B. amylovorus) from active blight canker on apple branch from which the gummy exudate was oozing. Stained carbol fuchsin; X 900 di.

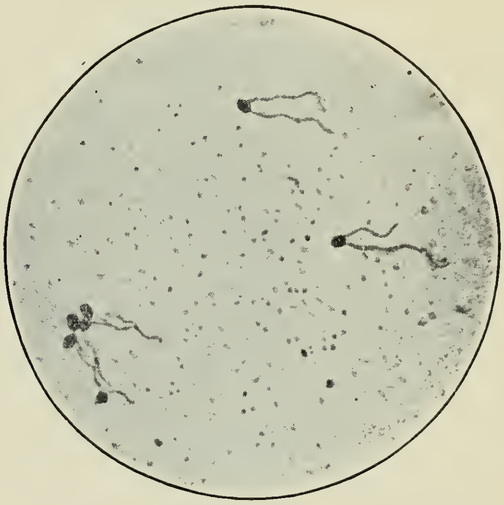


Fig. 2. **Erwinia amylovora** (B. amylovorus) stained to shown flagella; X 900 di.

SYMPTOMS: As the name fire blight implies, the blighted parts of a tree look as though they had been scorched by fire. The foliage of affected parts becomes dry, shrivelled and discoloured a dark brown to black in case of pear, a reddish brown in case of apple and quince. In case of blossom infection the blossoms wither and die and the dead and blackened peduncles and calyces frequently remain in position on the fruit spurs during the season, and often throughout the ensuing winter. The browned or blackened shrivelled foliage on twigs that have been killed by the blight early in the season often remains intact during the following winter.

Where the disease occurs in the bark of the larger limbs or trunk a cankered condition becomes visible on the surface as a brownish or purplish discoloured, somewhat sunken area, sometimes cracked and blistered and with a gummy exudate oozing from the pores, cracks and crevices.

The disease may also develop in the growing fruit, more particularly the young fruit, the inner tissues of which become soft and slimy, later shrivelling and drying up, forming shrunken, blackened, hard, mummylike fruit which stays on the tree.

Any one or all of these parts in the same tree may be infected and the disease may spread directly from one part to another with the progress of the pathogen locally from its point of entrance as from the blossom to the peduncle, thence to the fruit spur and from this to the branch and from the branch to the trunk. Each unit of the disease on the tree however, is the result of a separate infection. The disease is therefore not systemtic but local, spreading around each point of infection. Any portion of a tree from a single

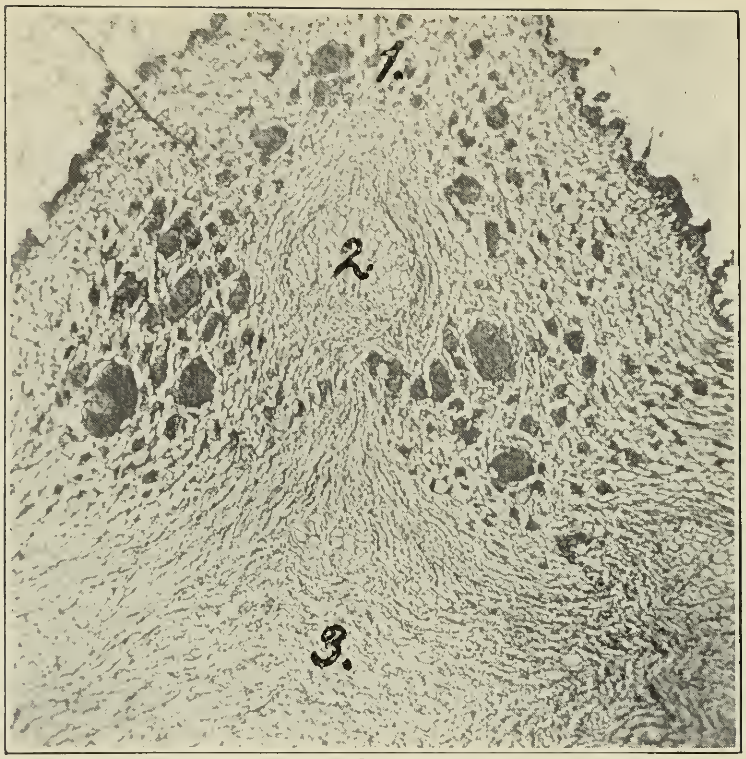


Fig. 3. Cross section of diseased pedicel of young apple. The darkened areas in the bark are injured cells and intercellular spaces crowded with bacteria. X about 50 di.

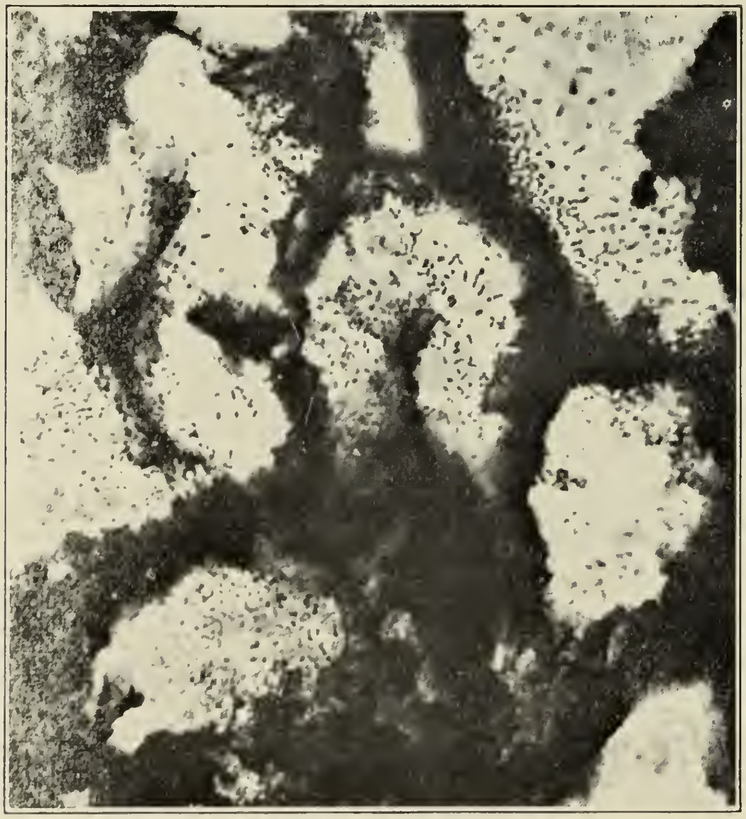


Fig. 4. Cross section of diseased young apple fruit obtained from the pedicel shown in fig. 3, showing bacteria within the cells and intercellular spaces. X 900 di.

twig to the entire head may show the characteristic signs of the disease. In the latter cases, as a rule, there will have been many points of inoculation. If however, the bark of the trunk has been the primary seat of infection the blight canker may girdle the trunk, in which case the entire head may die from the one inoculation as a result of girdling by the blight canker. Such cases are more common in young trees than in more mature specimens.

THE DISEASE IN THE BLOSSOMS: (Blossom Blight)

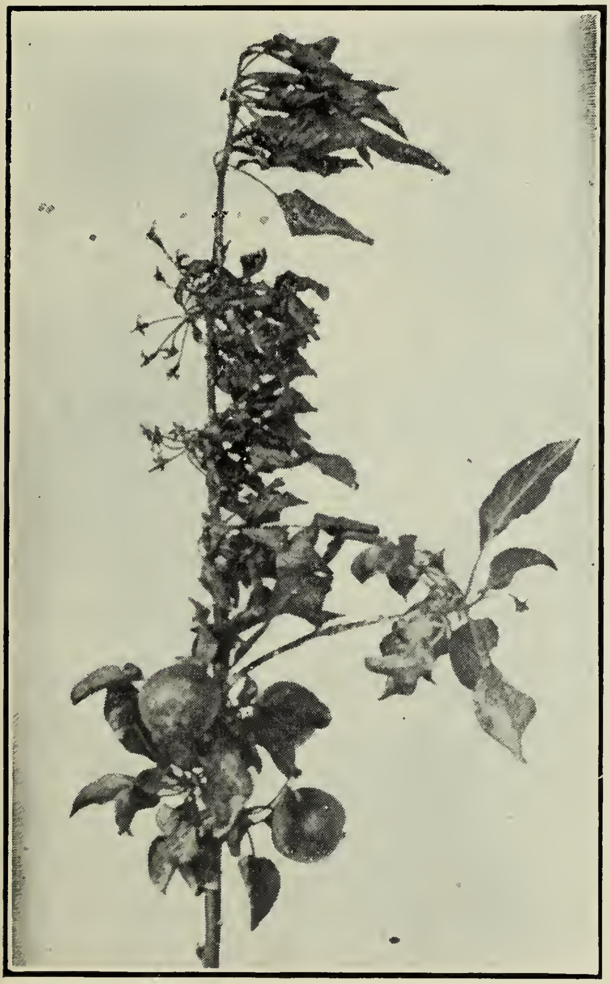


Fig. 5. Fire blighted apple twig; inoculation through blossoms on the two fruit spurs, presumably by bees. Disease progressed down pedicels to spurs, then to twig killing the end of the twig. Apples developed below the diseased area, but the disease later passing further down the twig would prevent their maturing.

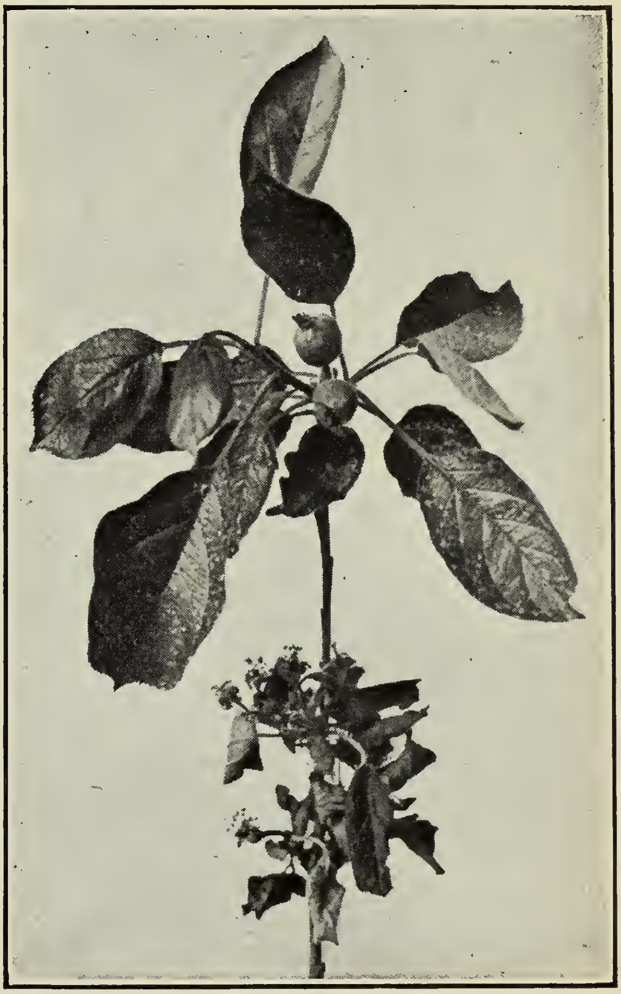


Fig. 6. Apple twig with two blighted fruit spurs; inoculation through the blossoms by contaminated insects. The disease had passed from the spurs to the twig, and when photographed the twig was girdled by the disease near the spurs and the apples and leaves at the tip had ceased developing and would soon wither.

Primary infection of the blossoms is usually brought about (1) by rain washing and splashing the exudate from hold over cankers on to blossom buds, and (2) by bees and other flower visiting insects whose mouth parts have become contaminated with the bacteria from hold over cankers or other cases of the disease, such as blossoms that have been inoculated by rain splashings. Such insects on thrusting their contaminated probosces into the nectaries, inoculate them. Here the bacteria rapidly multiply, kill the blossom and pass on from the nectaries to the peduncle down which they travel generally through the intercellular spaces cankering and killing the tissue as they progress. If some of the blossoms on a cluster have not been inoculated they may set and the fruit develop while the disease is passing down the peduncles of those blossoms of the same cluster that have been inoculated. When from these latter the bacteria enter the bark of the fruit spur they may spread through the bark tissue in all directions; and on reaching the base of healthy peduncles pass up these until eventually they reach the young fruit at the tips which soon die from the disease and often remain in position throughout the season as shrivelled, dark brown or black mummified fruit. Or, the disease may kill the spur before the bacteria get very far up the healthy peduncles, then the fruit at the tip dies from lack of nourishment without having the disease develop within it. Or, the disease may be checked by unfavourable conditions before it has done much damage to the fruit spur. In that case there may be one or more dead blighted blossoms on a fruit spur together with fruit that may reach maturity.

THE DISEASE IN THE TWIG: (Twig Blight)

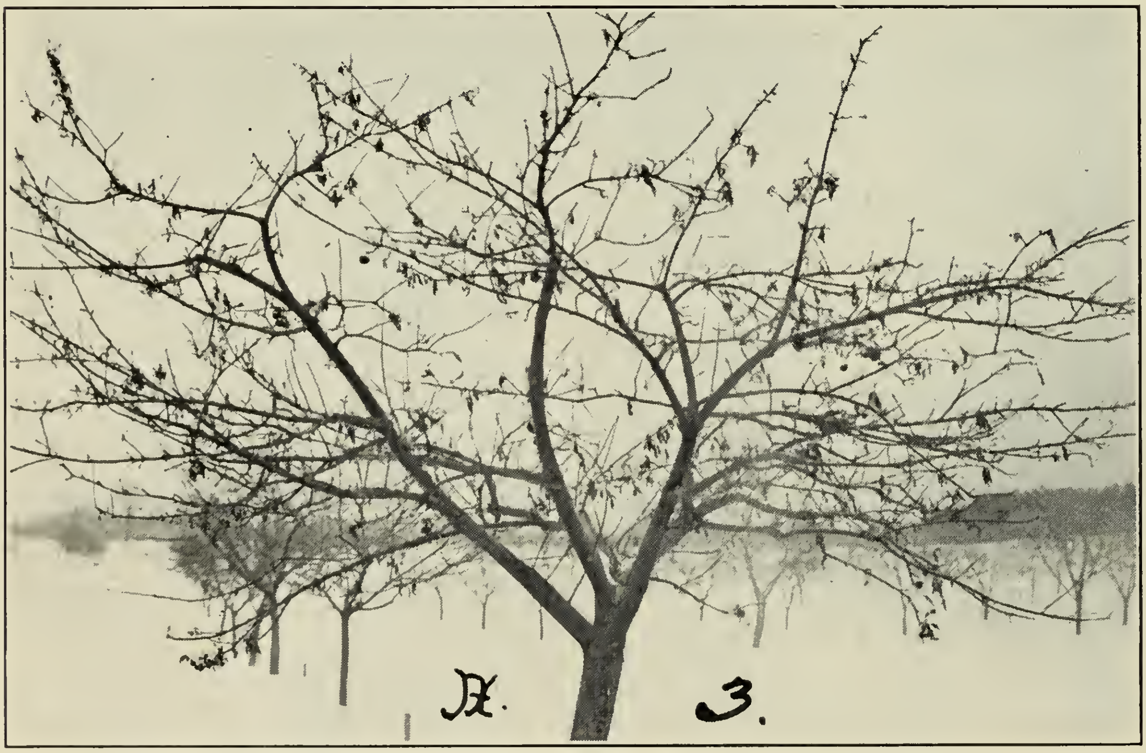


Fig. 7. Winter aspect of an apple tree that had been badly fire blighted during the previous season as a result of numerous blossom inoculations by contaminated bees and twig inoculations by contaminated aphids. Practically all the young growth on this tree was killed out in one season and many blight cankers developed on the larger limbs at the base of diseased twigs.

Infection of twigs may take place in various ways,—(1) Following blossom infection, that has caused the disease to develop in the bark of fruit spurs, the pathogen may pass from the bases of the infected spurs to the bark of twigs from which the spurs are growing. It may then spread either up or down or both up and down or around the twig. In the latter case, the twig being girdled, the distal end dies from lack of nourishment. When this occurs the leaves above the girdled area become brown and shrivelled and die, but remain attached usually throughout the season. (2) Another common way in which the disease gets established in twigs, watersprouts and suckers, particularly of apple trees, is for the pathogen to be brought by aphids, or other plant sucking insects, that have become contaminated on trees suffering from the disease. These settle on the tips of young, sappy, succulent growths and inoculate the tender bark tissue when they puncture it for feeding purposes. In such tissue the disease spreads rapidly as the pathogen finds ideal conditions for multiplication and rapid progress along the intercellular spaces. The disease may travel down the twig at the rate of from a quarter of an inch to two inches a day, the rate of its progress depending largely upon the succulency of the twig and the atmospheric temperature. The more juicy the twig the more rapid is the development, and warm, moist days are more favourable to the progress of the disease than cold days. Accompanying this development there is a shrinkage and brownish discolouration of the bark and frequently an oozing out of a gummy exudate which at first is almost colourless and transparent, but as the moisture evaporates from it, it becomes first amber coloured, then brown, and when dry adheres to the surface like layers of varnish. This exudate is crowded with the germs of the disease, and if by any agency, as insects, workman's tools or careless handling of diseased parts, the germs find entrance to the bark of healthy parts of the same tree or other trees, there the disease will likely develop.

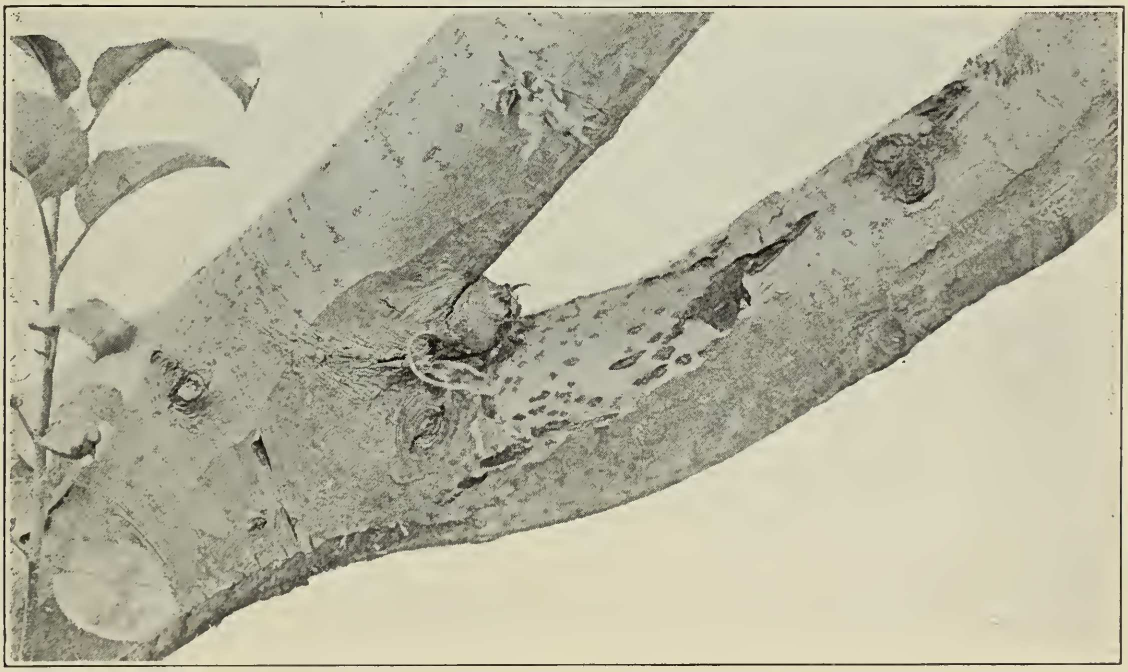


Fig. 8. Large blight canker rapidly spreading in a crotch of main limb of apple tree. The whole of this canker developed in two months after inoculation by aphids through a watersprout growing in the crotch.

THE DISEASE IN THE MAIN LIMBS AND TRUNK:

1. *In the Apple Tree*—Where the disease occurs in the main limbs or trunk of the apple tree it is usually confined to a well defined and somewhat limited area which gradually enlarges. This is the phase of the disease called "Blight Canker." Fully ninety per cent. of such infections are due to twigs,

water-sprouts and suckers being primarily infected. Down these latter the disease progresses until it reaches their base from which it usually spreads in all directions within the bark of the larger growth. So long as suitable conditions are obtained in the older growth the disease will continue to spread there. While the disease is active the bark affected will usually be a little darker in colour than the healthy bark, and will usually appear somewhat moist, as if water-soaked. Sometimes it will be slightly raised, and if there be plenty of sap in the bark it will usually blister and the characteristic gummy matter loaded with the germs will exude. As soon as unfavourable conditions obtain, as for instance, a diminution of the sap supply, which may be induced by lack of cultivation, drought, or cold weather, the progress of the disease is checked. When the disease ceases to be active the affected bark shrinks and subsides, and in doing so it is torn from the healthy tissue surrounding it and a crack is thus formed, usually entirely encircling the dead portion.

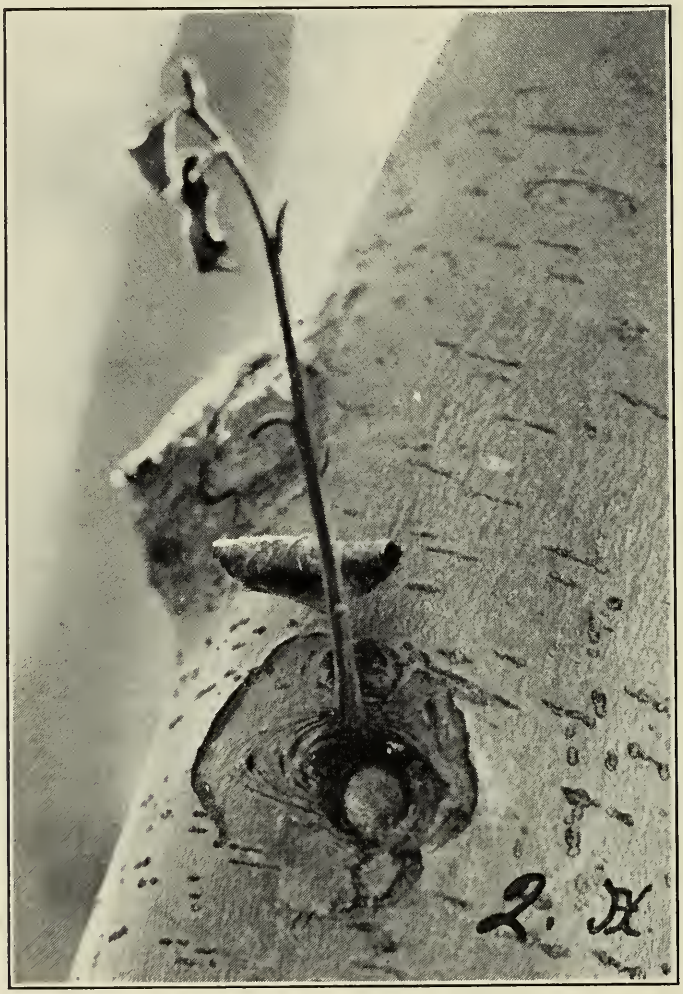


Fig. 9. Typical blight canker at the base of a blighted water-sprout the tip of which had been inoculated by contaminated aphids coming from a fire blighted tree near by.

When cut with a knife the diseased inner bark will appear brown, while the healthy inner bark surrounding it will be pale green or creamy white in colour, and the line of demarcation between these is usually sharp and distinct. The dead bark is very tough. Sometimes germs will have pushed beyond the well defined cankered area and will remain alive but not very active in the apparently healthy tissue until favourable conditions once more obtain, when they will resume their activity and another cankered area surrounding the old one will thus be produced. Sometimes a series of such cankered areas will develop, the more recent ones encircling the older ones, due to a repetition of the necessary conditions for growth, each crack separating one cankered area from the others, representing the termination of a period of activity. Blight canker, or collar blight, may develop at the base of the trunk or crown from infected suckers, also from injuries with contaminated cultivators. In this way the disease may also get established in the root.

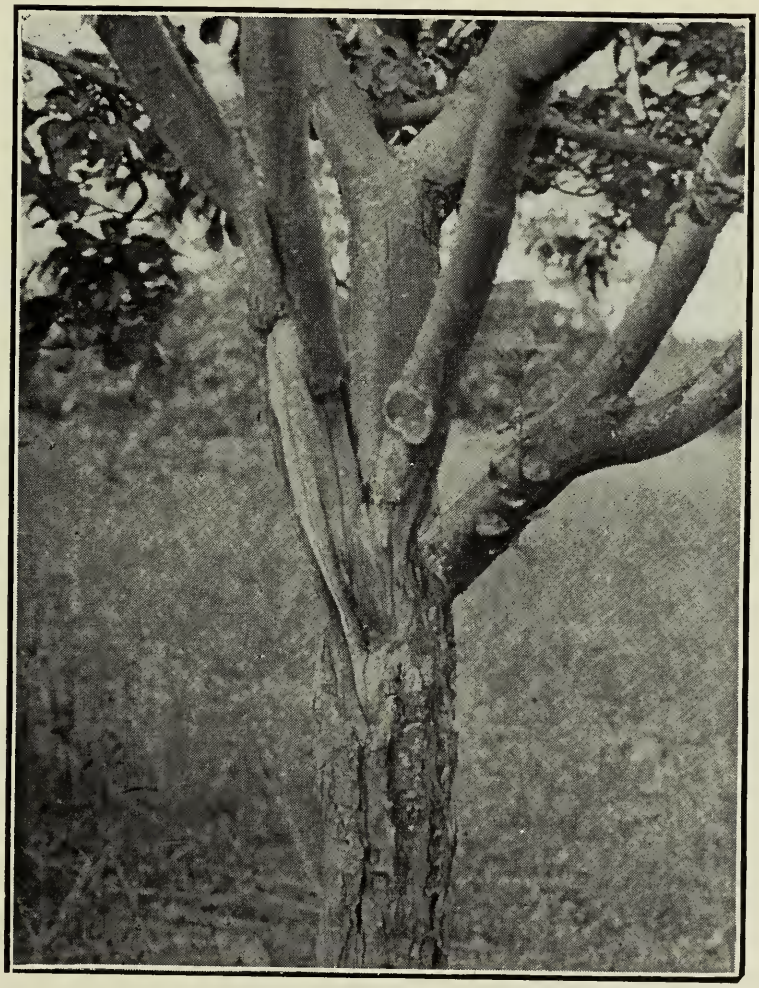


Fig. 10. Wound on a main branch of a mature apple tree where the bark had been blight cankered and killed. The blight canker spread to the other limbs and trunk, killing the tree during the following season.

The canker originated at the base of a water sprout, the tip of which had been inoculated by contaminated aphids. If the blighted water sprout had been cut away before the disease had reached its base there would have been no blight canker on the limb.

2. *In the Pear Tree*—As above intimated, while the disease does not cause so much loss by its development in the bark of the trunk and main limbs of apple trees as it does in the twigs and smaller branches of the same, with the pear it is the reverse conditions that prevail.

When once the pathogen finds entrance to the bark of a main limb or trunk of a pear tree it seldom dies out until the whole tree is dead, unless the diseased area is radically removed. Especially is this the case with the choicer varieties of pears,—the Duchess, Bartlett, Flemish Beauty, Clapp's Favourite and Clairgeau, for instance. When once these trees are attacked they seldom live more than three years if the disease is allowed to have its way, unless they are kept in sod, when the disease does not spread so rapidly.

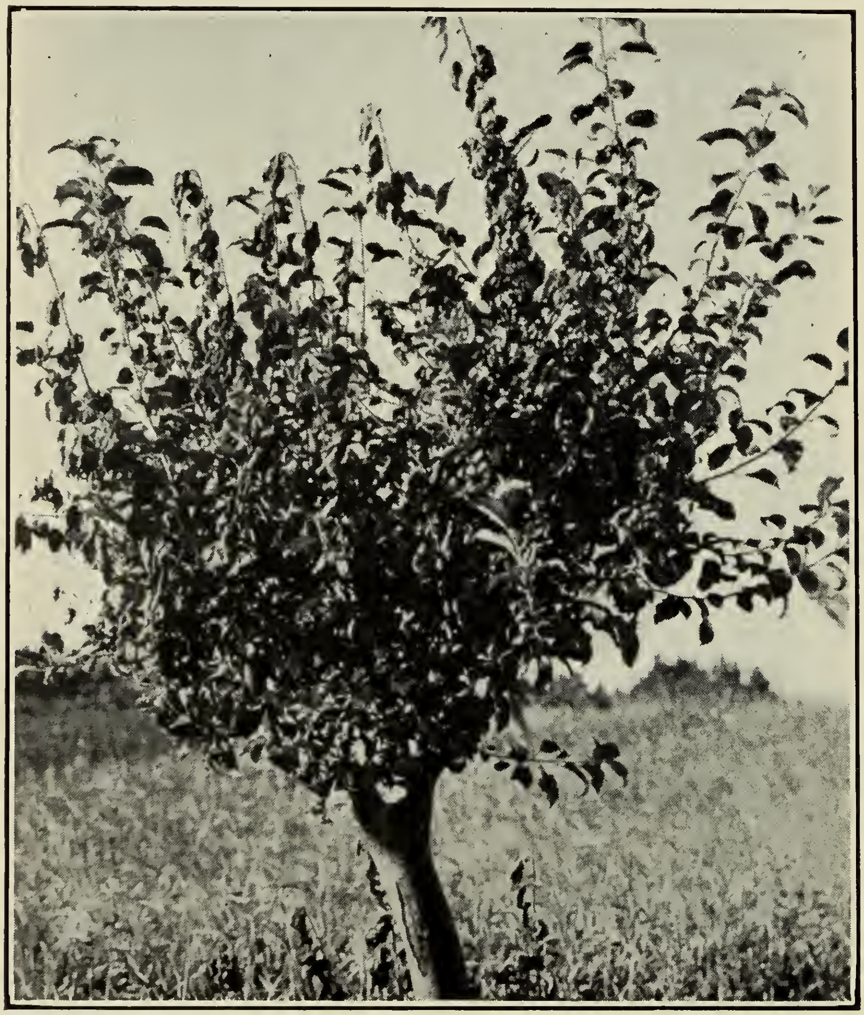


Fig. 11. Young apple tree with about 90 per cent. of its twigs killed in two months by fire blight. Most of the leaves were dead, shrivelled and brown when the photo was taken in September. There were numerous suckers growing from the crown, all of which were badly diseased. All the diseased twigs and suckers had been inoculated with the germs of the disease by contaminated aphids coming from nearby fire blighted trees.

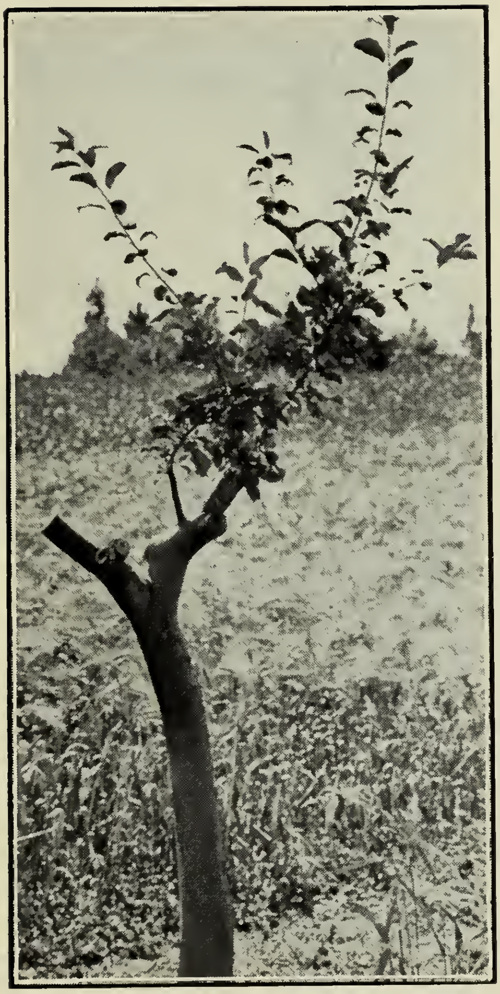


Fig. 12. Same tree as shown in Fig. 11 after all fire blighted parts had been cut away. Fortunately the disease had not reached the base of the suckers, so that when the suckers were cut away it prevented blight canker from developing at the crown or collar. This tree was used for grafting purposes the following season and is now well grown and bearing fruit. If the diseased parts had not been cut away the tree would have been dead the following season.

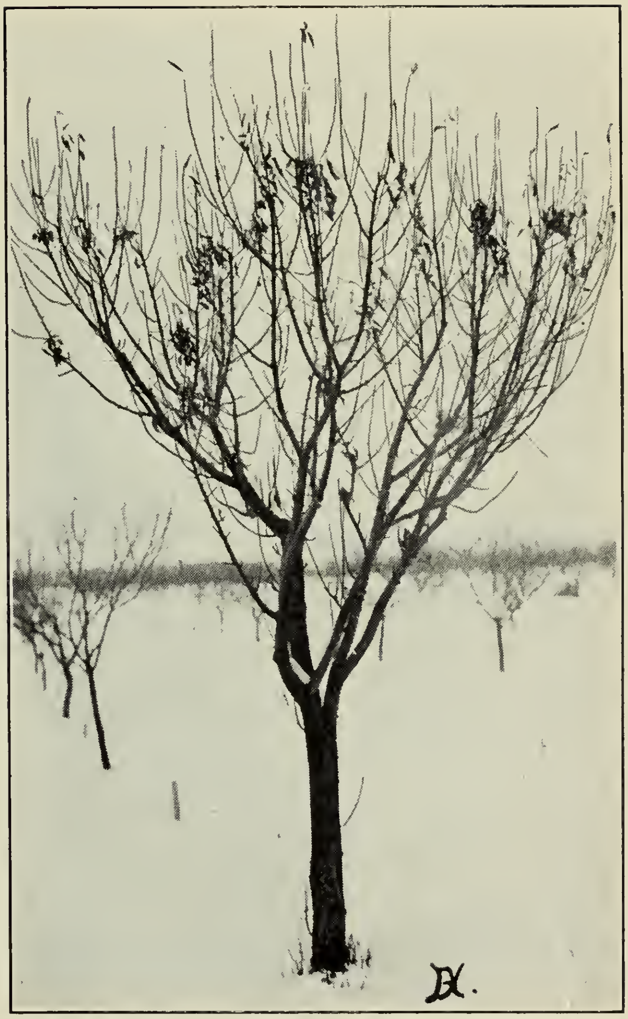


Fig. 13. Apple tree showing winter appearance of twigs and small branches that had been killed by fire blight during the previous season, following blossom inoculation by contaminated bees, and twig-inoculation by contaminated aphids.

By judicious pruning out of diseased larger branches as well as cutting out the dead material, the tree was saved.

The disease develops and spreads in the main limbs and trunk of pear trees in much the same manner as in the twigs. The exterior of the bark becomes discoloured, sometimes brown and sometimes purplish. It often blisters and cracks, and amber coloured gummy exudate emerges when the disease is most active. This may often be seen flowing slowly down the face of the diseased area. The disease is much less active during the winter than during the summer, though the complete cessation of its activity during the cold period is questionable. In the spring the tissue surrounding the dead cankered area is teeming with the disease germs, which on the flow of sap begin rapidly to develop and spread farther afield. The disease is irregular in its progress. It may spread in any direction, and the cracks mark its periods of activity, and may be longitudinal or horizontal, but are seldom oval or circular as in the case of the apple. These periods of activity vary in duration, depending somewhat upon climate and soil conditions which regulate the flow of sap—more sap, more disease, if the germs be in the tree.

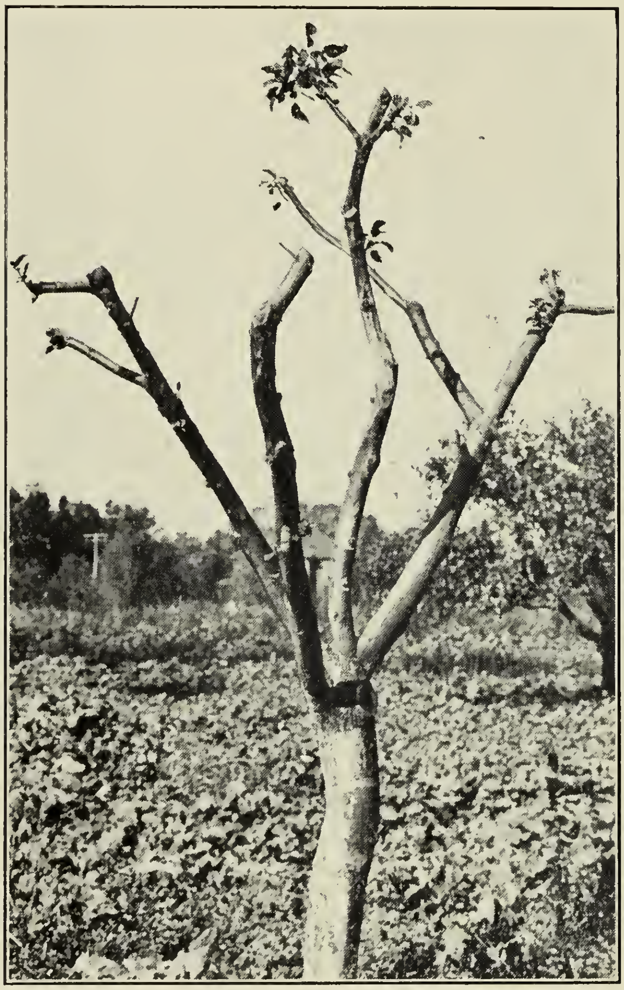


Fig. 14. Apple tree that had been heavily blighted during the early season through many blossom inoculations by contaminated bees and twig inoculations by contaminated aphids.

Cutting out the diseased as well as the killed material necessitated the treatment shown during early fall.

It is this fact that is responsible for the idea that so largely prevails among pome fruit growers, that orchards under cultivation are more subject to fire blight than are orchards in sod. The trees in orchards that are fertilized and cultivated naturally produce more young growth and are more sappy than those in sod, and this condition being the most favourable for the rapid development of the organism, should it be present in the trees, the spread of the disease in these trees is much more noticeable than in trees that are less thrifty. Pear orchards may be in sod a number of years and the disease be present in the trees, but progressing so slowly as to be scarcely noticed by the

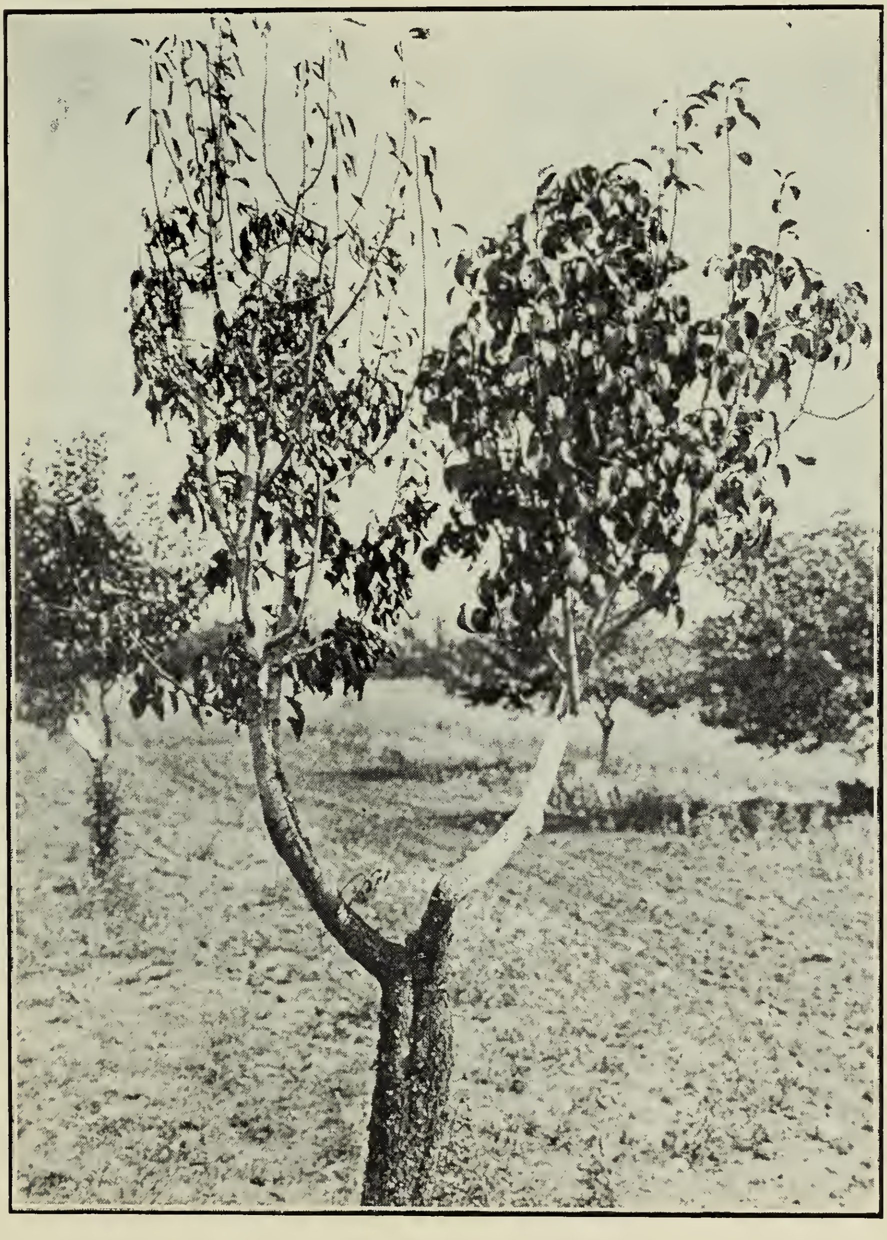


Fig. 15. Mature Bartlett pear tree very badly diseased with fire blight. Disease had been active in this tree for four years. Dead limbs were cut away from time to time but care was not taken to cut out all the diseased parts at the same time. Consequently the disease continued to spread as blight canker in the bark of the larger limbs and trunk during each growing season. The limb to the left died during the current season and the limb to the right died the season after the photo was taken.

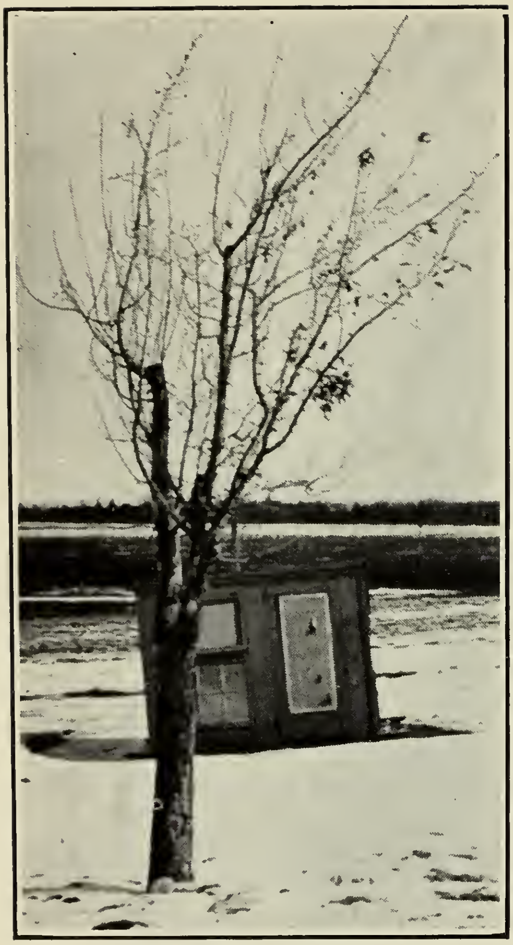


Fig. 16. Winter appearance of a mature Flemish Beauty pear tree badly diseased with fire blight. Note clusters of dead shrivelled leaves still hanging on twigs that had been killed early the previous season by the blight. The disease had spread down from these branches to the bark of the larger limbs where it had produced blight canker. (Photographed in February.)

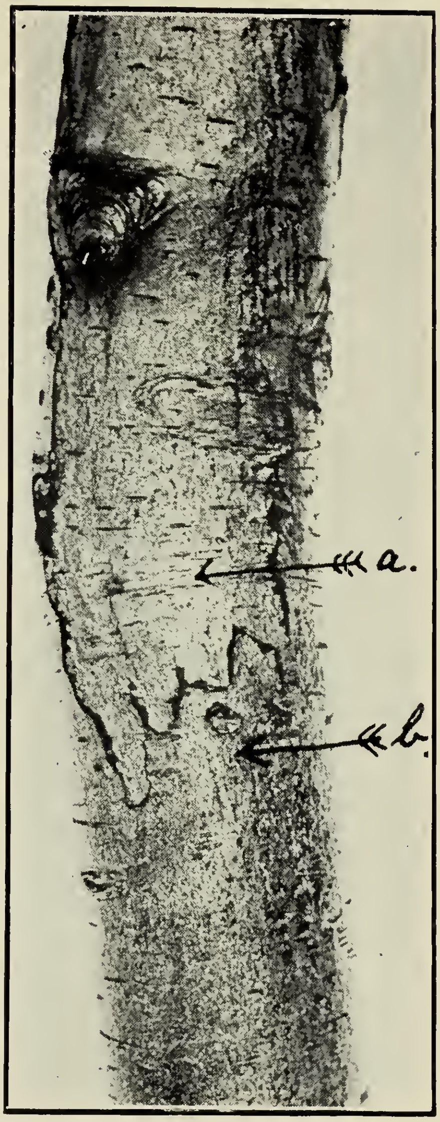


Fig. 17. Large branch cut from the same tree as shown in Fig. 16, showing the lower limit of blight canker outlined by an irregular crack. The tissue in this cankered area was dead and contained no fire blight bacteria. There were many living fire blight bacteria, however, in the living bark tissue outside the visibly cankered area; some were present four inches below the crack. When the sap began to flow in the spring these bacteria would become active and so continue to spread the blight canker.

owner. At length the owner decides to plough up the sod and cultivate. This results in the greater flow of sap in the trees, produces ideal conditions for the rapid development of the disease, and before the season is over dead limbs and trees are seen in all directions. The owner, disgusted, destroys the dead material and allows the orchard to return once more to sod, deeming it better to have a decreased yield of fruit than to have the trees killed out wholesale. The spread of the disease slowly subsides, falls to proportions in which it is not very noticeable, and the owner decides that the attack of the disease was due to the cultivation; which, of course, indirectly it was. A number of such cases have come directly before our notice.

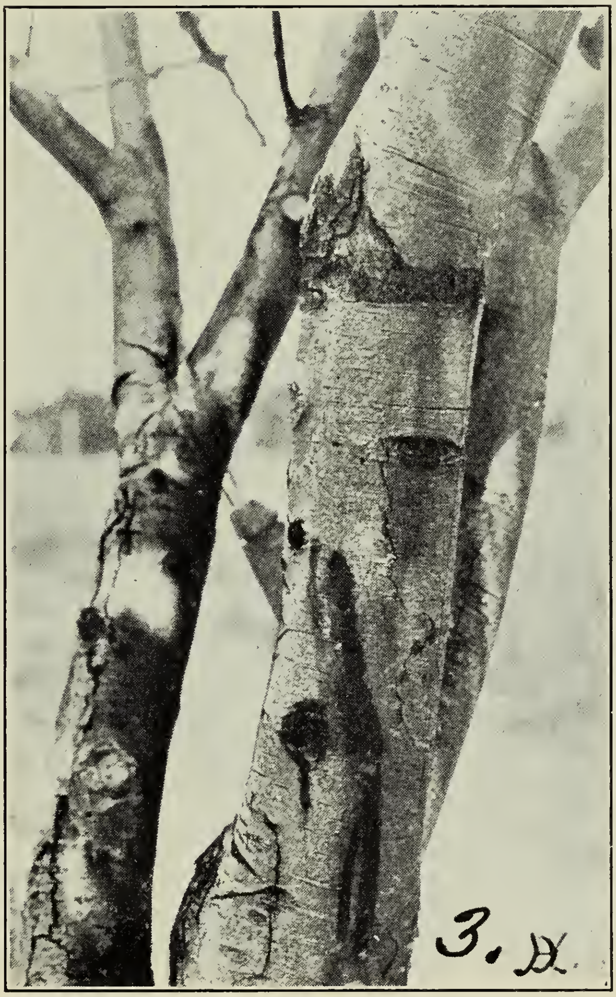


Fig. 18. Main limbs of same tree as shown in Fig. 16, showing a dead limb to the left and blight canker very active in the bark of the limbs to the right. Note the sticky, slimy exudate oozing from the cankered area and slowly running down the outside of the bark. (Photographed in July.)

Sod, however, is not an ideal condition for an orchard. It means a diminished supply and a somewhat inferior quality of fruit, and it is a nursery for numerous insect pests, and the disease is not killed out, but merely spreads more slowly. This being the case, what is the pome grower to do? The best thing is to find a more direct method of attacking the blight than merely diminishing its spread by leaving the orchard in sod.

DISSEMINATION: Fire blight bacteria are spread around in various ways, e.g., by rain splashings from other cases of the disease on the same tree, by insects, pruning tools, cultivators, etc. The most common way in which the organism is carried from tree to tree and from orchard to orchard is by insects.

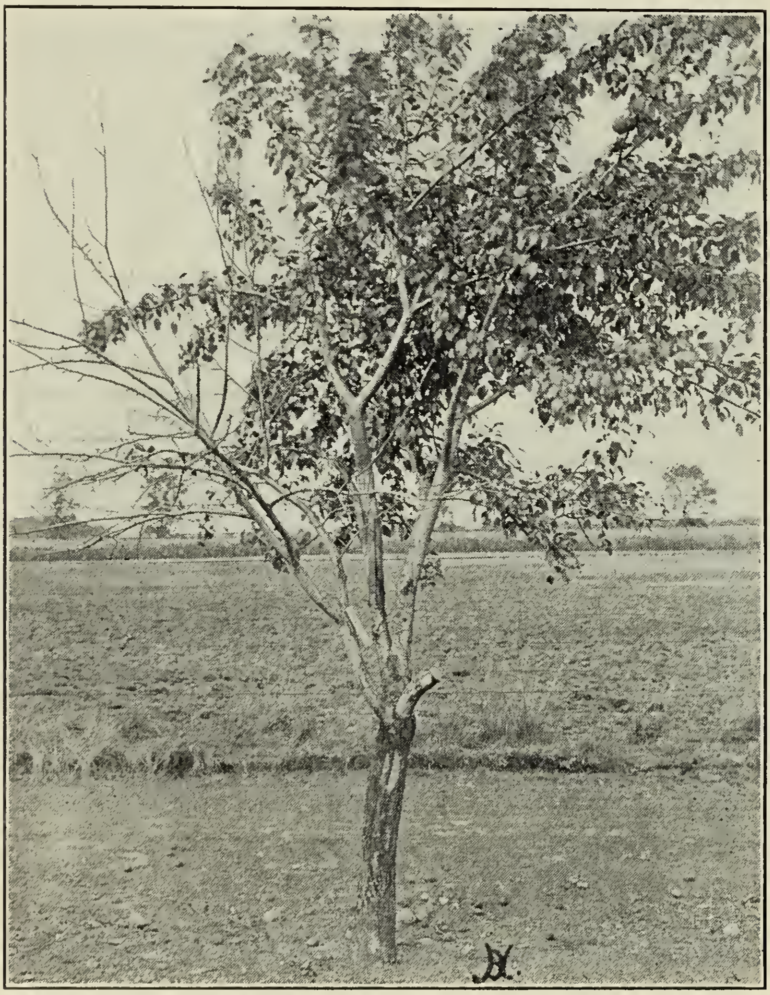


Fig. 19. Summer appearance of fire blighted pear tree shown in Figs. 16, 17 and 18.

I. *Insects*—(1) Flower Visiting Insects—Bees, wasps and flies that visit the blossoms in search of nectar are responsible for most cases of blossom infection. A very large percentage of cases of the disease are due to infection through the blossom. These insects, after getting their mouth

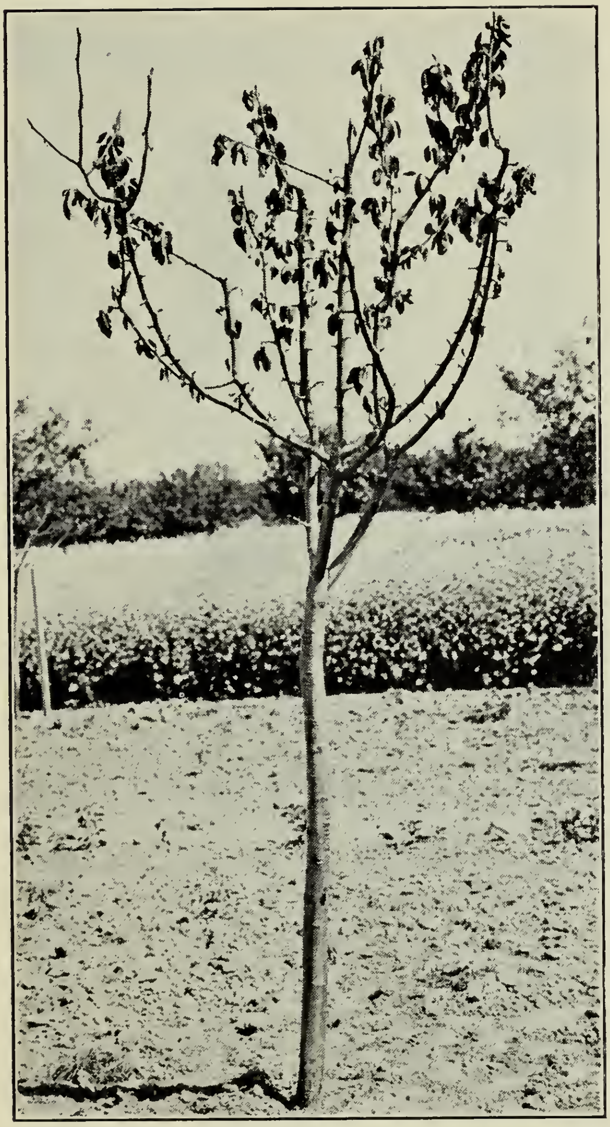


Fig. 20. Young pear tree killed by fire blight canker which girdled the trunk about eighteen inches above ground level.

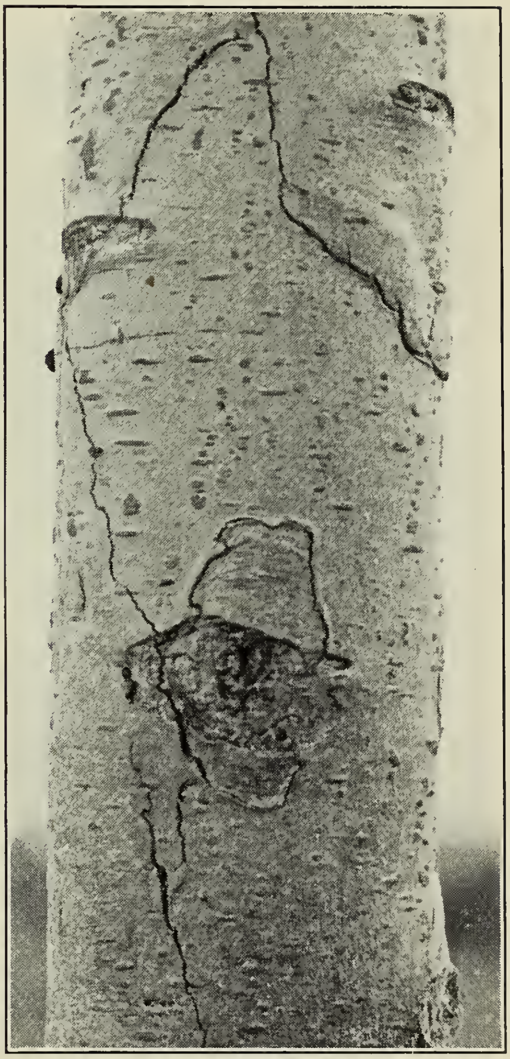


Fig. 21. Close up view of the fire blight canker which killed the tree shown in fig. 20.

The canker had developed around a small hole in the bark made by a contaminated shot-hole bark-boring beetle. During the season in which the boring was made the canker spread as far as the irregular circular crack seen in the middle of the photo. During the following season it spread until it had girdled the trunk and killed the tree.

parts contaminated with the bacteria from a diseased tree, carry them to the flowers of healthy trees, and as they burrow down into the flower to get the nectar, some of the bacteria are left in the nectaries of the flower. Here they find suitable food for their development and multiplication, and as they multiply they pass down the cortical tissue of the blossom peduncles to the fruit spur, cankering and killing the tissue as they advance.

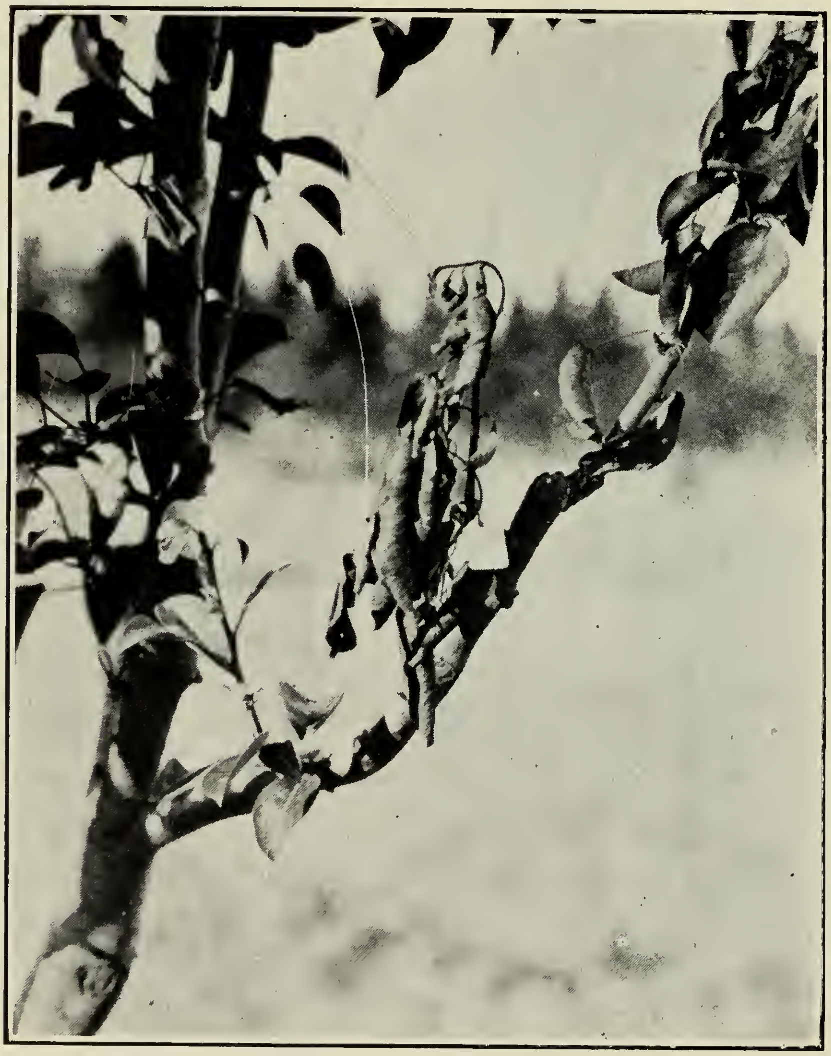


Fig. 22. Portion of a healthy Flemish Beauty pear tree used for experimental inoculation purposes, photographed in September. The tip of the twig in the centre of the picture was inoculated by needle puncture in July, the point of the needle having been previously dipped in a pure culture of the fire blight bacteria isolated in February from the cankered limb shown in fig. 16. The bacteria had gradually made their way through the living bark tissue from the point of inoculation at the tip, all the way down the twig to the large limb on which it was growing. The twig was killed and the large limb was girdled with blight canker at the base of the twig and was dying as a consequence. By cutting off this branch at the point of juncture with its parent branch the blight canker was prevented from spreading further in the tree.

(2) *Sucking Insects* that puncture the bark, such as aphids (*Aphis mali*) and woolly aphis (*Schizoneura lanigera*) frequently convey the fire blight bacteria from branch to branch and from tree to tree in apple orchards. These are responsible for many cases of the disease starting in suckers, water-

sprouts, and young twigs that have no flowers, also for much of the infection of young trees in nurseries.

(3) *Boring Insects*, such as the shot-hole bark-boring beetle (*Scolytus rugulosus*) have been shown to be responsible for many cases of the disease in pear trees, both young and mature, as a result of their getting contaminated by boring in blighted trees and then in healthy ones.

II. *Rain*—washing the bacterial exudate from the surface of active cankers and then dripping over blossom clusters, water-sprouts, suckers and young twigs, is responsible for many cases developing in such young tissues.

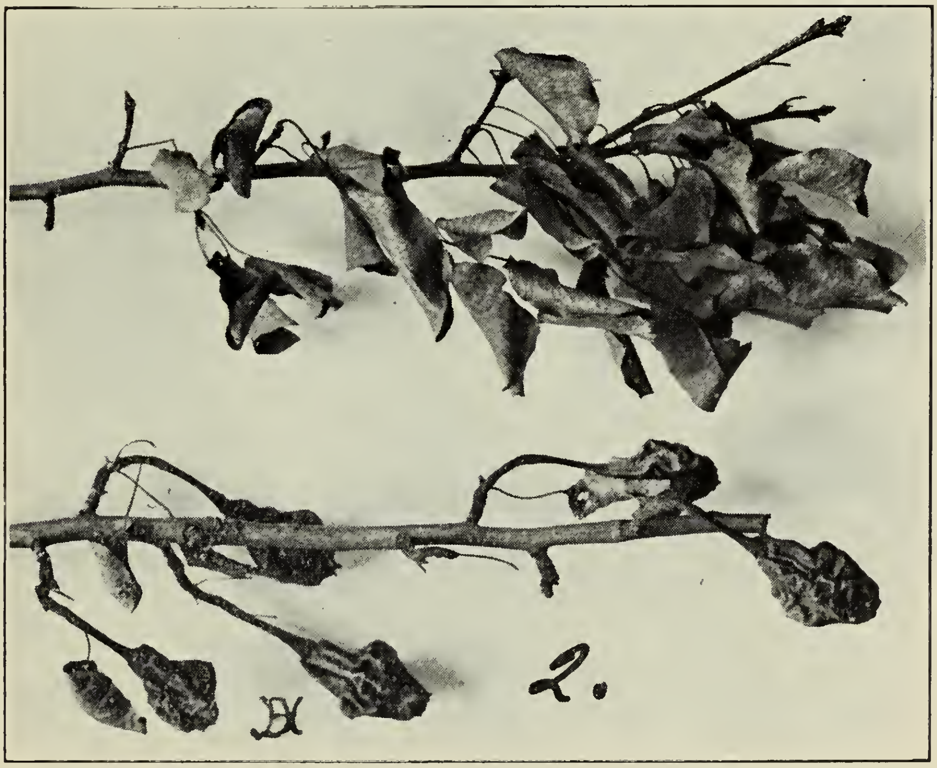


Fig. 23. Two dead twigs from a pear tree, one showing cluster of dead, shrivelled, blackened leaves, and the other showing dead, shrivelled mummified young pears. These twigs had been killed as a result of their being girdled by blight canker further down. The cankers which killed these twigs had developed at the base of fruit spurs that had been inoculated through blossoms by contaminated bees.

III. *Pruning Saws, Knives and Shears*—Many cases of the disease in apple and pear trees have been established following contamination of the pruning tools by cutting through a diseased branch and then through a healthy branch, the latter becoming inoculated from the contaminated pruning tool.

IV. *Cultivators*—getting contaminated with the pathogen by coming in contact with cases of blight canker on the crown and then wounding the crown or roots of other trees and thereby inoculating them, producing "collar blight" or "crown blight."

ERADICATION: It has been well established that the fire blight bacteria do not live over winter in the soil. It is not a soil organism. It has been observed that where infection is confined to the thin twigs, the bacteria usually die out during the following winter. It has been demonstrated that the bacteria will live several weeks, or even months, in the blight-cankered limbs that have been cut away and left lying around. As these dry out, however, the bacteria die with the dying wood. *It has been conclusively proved that fresh outbreaks of the disease in the spring and early summer owe their origin to hold over blight-cankers in the bark of branches, a half-inch or more in thickness, and blight-cankers in the trunks of trees, that were active during the previous season.* This being the case, *special care should be taken to cut out all cases of*

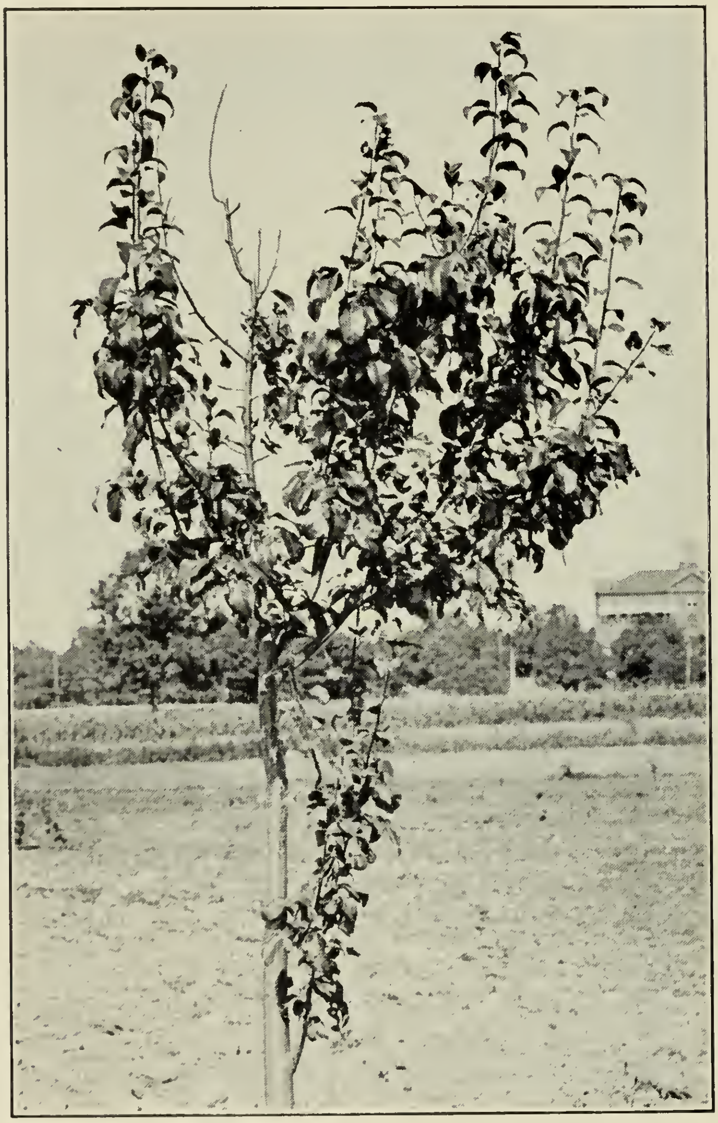


Fig. 24. Young, vigorous Bartlett pear tree with one branch killed by fire blight. This branch had been inoculated by contaminated pruning shears. The shears had been used for cutting out diseased branches on a near by tree, and were not disinfected before being used on this tree. The fire blight bacteria got from the contaminated shears on to the cut surface of the bark and gradually passed downward inside the living bark tissue cankering and killing as they went. At the time the picture was taken the blight canker had nearly reached the crotch. By cutting off the branch at the crotch the tree was saved.

blight-canker that occur in branches a half-inch or more in thickness and in the trunks of trees. Infected branches should be cut away several inches below the cankered area, as the bacteria may have progressed some distance beyond the visible boundary of the canker. In case of the canker in the trunk, all the cankered bark should be cut away, care being taken to cut into the healthy bark around the visible canker so as to ensure getting the bacteria that have spread into the tissue beyond the cankered boundary. The exposed wood should then be painted over. All diseased tissue that is removed should be carefully gathered and burned.

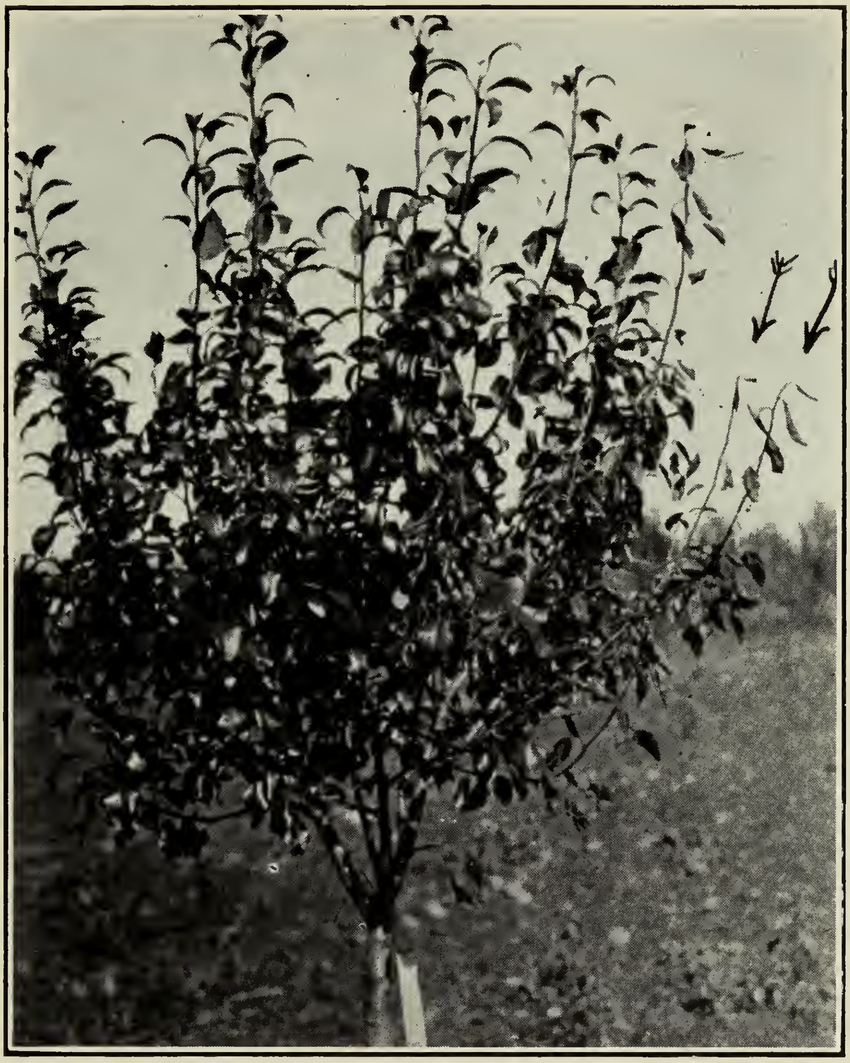


Fig. 25. Clapp's Favourite pear tree, used for experimental inoculation purposes. The photo was taken in September. The twigs on the extreme right of the picture had been experimentally inoculated early in July by needle puncture at the tip, the point of the needle having been previously dipped in a laboratory culture of the fire blight bacteria. At the time the picture was taken the disease had passed with the progress of the bacteria from the tip of the twigs to the branches from which they were growing, and down these branches to the crotch, extending for a foot down the trunk and for about the same distance up each of the other branches arising from the crotch. By the end of the season the tree was dead.

As the blight-cankers on large limbs, trunks and crowns of trees most frequently arise from infected watersprouts and suckers that have been inoculated by *contaminated insects or rain drip, the removal of such infected watersprouts or suckers before the disease reaches their base, will prevent cankers from developing in the bark of the limbs or trunk.* Therefore it is desirable to keep a sharp eye on watersprouts and suckers during the growing season and to cut them out on the first sign of fire blight developing at their tips. This would prevent the establishment of the far more serious blight canker in the large limbs, trunks or crowns or the trees. This is the ounce of prevention that is better than a pound of cure.

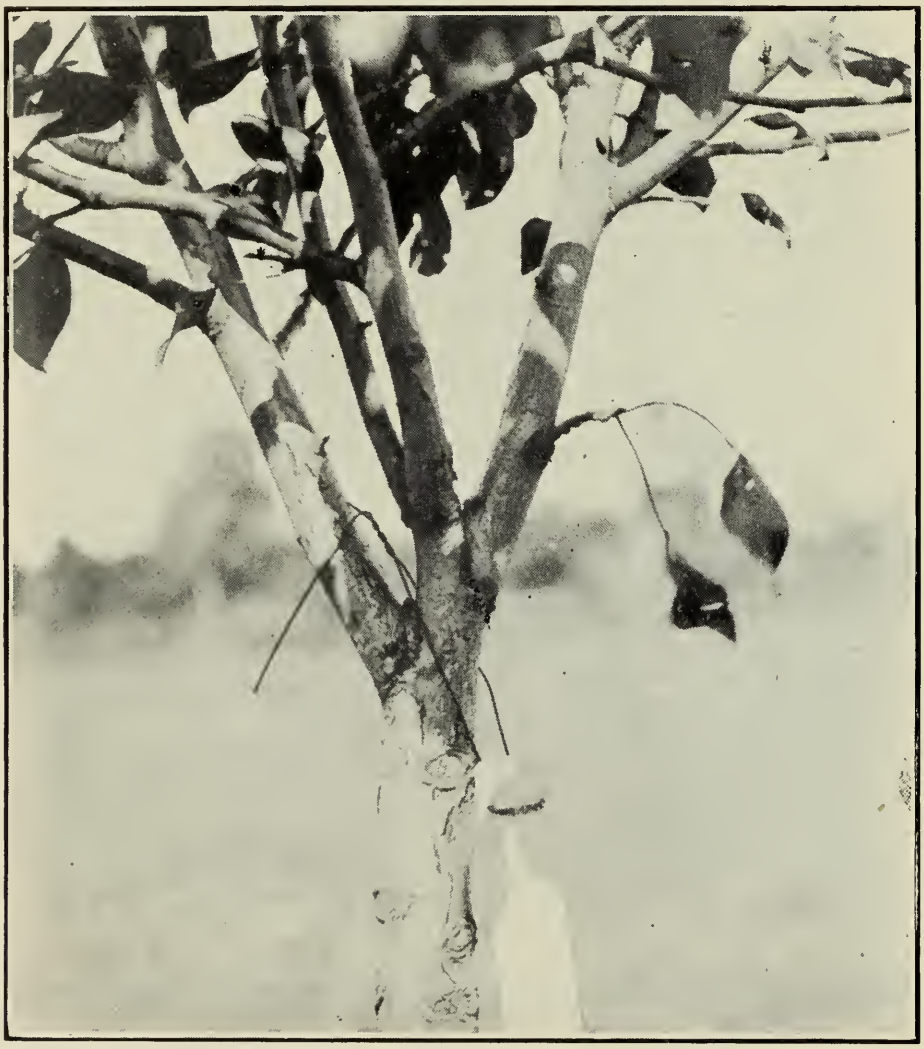


Fig. 26. Close up view of crotch shown in fig. 25, showing the cankered area outlined by cracks in the bark down the trunk and up the limbs. The disease came down the branch on the right from the tips of the inoculated twigs at its extremity.

BULLETIN 343] [APRIL, 1919

Ontario Department of Agriculture

HORTICULTURAL EXPERIMENT STATION

VINELAND STA., ONT.

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NEW FRUITS

By

E. F. PALMER, Director

Entrance to Horticultural Experiment Station.

INTRODUCTION

The plant breeding work of the Horticultural Experiment Station has now developed to the point where it seems advisable to make a permanent record of the progress to date. This bulletin therefore is written with that purpose in mind. In a general way it will deal with the following phases of the breeding work:

(1) An outline of the various fruit breeding projects, particularly those dealing with strawberries, raspberries, cherries and peaches. In these fruits new varieties have been named and introduced.

(2) Descriptions, non-technical, of the Station originations and introductions.

(3) Brief descriptive notes of the more promising newer seedling fruits not yet named or introduced.

(4) Dissemination of the varieties introduced.

FRUIT BREEDING PROJECTS

Extensive and systematic breeding work is being carried on with the following fruits—strawberry, raspberry, apple, cherry (sweet), peach, pear and grape. Somewhat less extensive work is under way with other fruits, including the plum, currant, gooseberry, apricot, black raspberry, blackberry, etc. Definite projects, having some particular improvement in mind for the fruit in question, are planned for each fruit. The chief breeding projects and the extent of the work are indicated in a general way in the following paragraphs.

The Strawberry

(1) Improvement in size, quality and productiveness of early varieties.

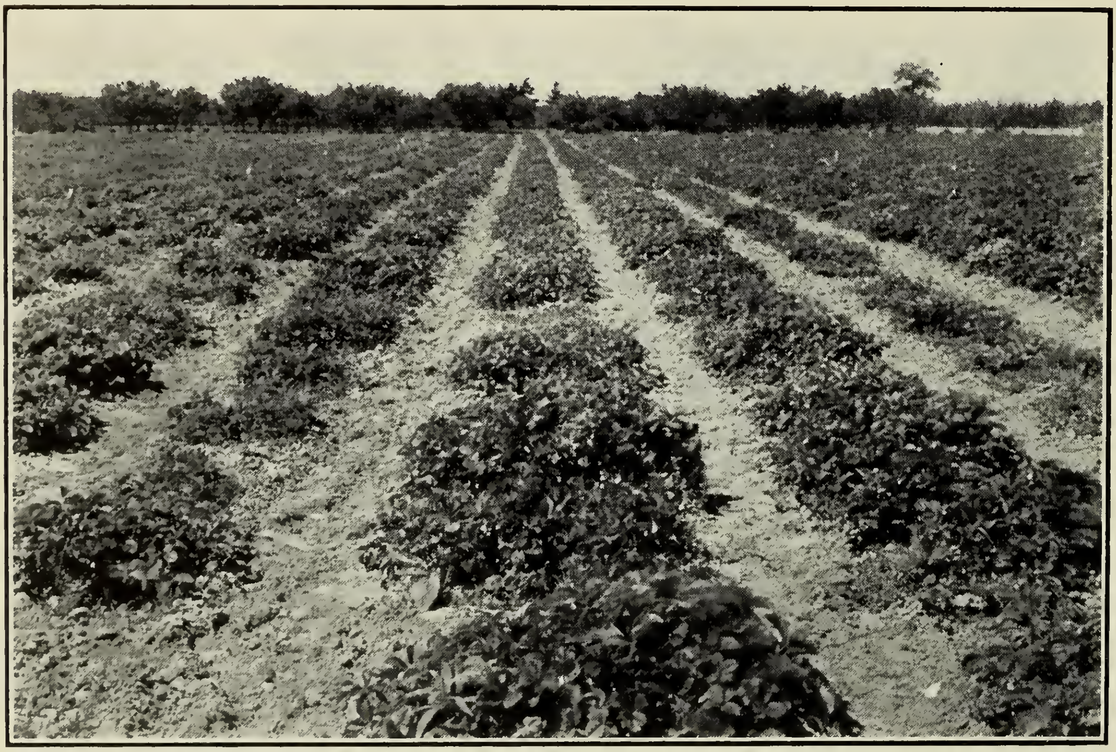


Fig. 1.—A field of six thousand seedling Strawberries. Each clump represents an individual raised from seed.

(2) Main season varieties possessing the canning and jam-making qualities of Portia, but of the perfect bloomed type.

(3) Crossing of "Old Country" or English varieties with our present commercial sorts to secure seedlings possessing something of the quality of the English type, but retaining the adaptability to Ontario conditions of our own varieties.

In crossing and selecting in all of the above projects, of course, the fundamental requisites of a good commercial variety are always kept in mind. These requisites include vigor, hardiness, productiveness, quality, firmness of berry, internal and external color, etc.

Since the inception of the strawberry breeding work in 1913, approximately 22,000 seedling plants have been fruited. Nearly three hundred crosses have been made at one time or another, using practically every variety of any importance and many little known varieties. Numerous selections have been made and propagated for further test. Of these selections, two, later described in some detail, have been named and introduced.

The same field as in Fig. 1 after the promising seedlings have been selected and the others plowed under.

Many others are still under test, either at the Experiment Station alone or with interested growers in the various commercial strawberry sections.

THE RED RASPBERRY

(1) Improvement of early varieties in size, quality and productiveness.

(2) Resistance to "mosaic" and virus diseases generally.

(3) In a general way improvement is sought over present main crop commercial varieties in hardiness, productiveness, vigor and uprightness of growth, and size, firmness, quality and color of fruit.

A plantation of seedling Raspberries the second year from seed. New varieties resistant to "mosaic" diseases are being sought. In the field illustrated above all the plants have a resistant variety as one of the parents.

The red raspberry breeding work was started in 1913. Two hundred and sixty varietal crosses have been made, exclusive of 1927 and 1928 breeding, using the following varieties mostly—Cuthbert, Erskine Park, Herbert, Latham, Marlboro, Viking and Adam's seedlings Nos. 34, 87 and 101. Of the many selections made from the resulting hybrids (18, 434 in number), one only, Viking, has as yet been named and introduced. Many other selections of promise remain under test.

OTHER BREEDING WITH RUBUS SPECIES

While the main breeding effort with *rubus* species has been with the red raspberry, nevertheless considerable work has been done with the black raspberry, the purple raspberry, the blackberry, the dewberry and the loganberry. Interspecific crosses have also been made, such as crossing the raspberry, red, black and purple, with the blackberry, loganberry, etc. Such crosses have not always been productive of viable seed. Also, where hybrid plants have been secured, they have so far shown little promise commercially.

THE SWEET CHERRY

(1) Earlier and later maturing varieties of the firm flesh type.
(2) Improved quality in the firm flesh type of all seasons.
(3) Resistance to Brown Rot.

Much of the breeding work with sweet cherries has been productive of little result owing to the failure of the seeds to germinate. A great deal of work and many hundreds of pollinations have to be made to secure a handful or so of viable seed. Partly for this reason open-fertilized seed has been planted in considerable quantity from time to time. From this seed a number of selections have been made, one of which has been named and introduced.

Including approximately 1,000 seedling trees still in the nursery row, just over 2,000 cherry seedlings have been grown since the inception of the breeding work with this fruit in 1915. In the earlier work, as already indicated, most of the seedlings were from open-fertilized fruits, forty-five only being definite crosses between known parent varieties.

THE APPLE

(1) The growing of open-fertilized seedlings of a considerable number of varieties with a view to determining in some measure, for future breeding, the value of these varieties as parents.

(2) Production of improved long-keeping and high-color varieties. Better quality and increased hardiness are especially desired.

(3) Regularity of bearing.

In the first of the above projects open-fertilized seedlings of approximately sixty-five varieties are growing. From forty-eight to fifty trees of each parentage are represented, with a total of 3,314. Comparatively few of these have fruited to date, most of the trees being under ten years of age.

The cross-fertilization or hybridizing work includes ninety-four crosses from which 2,459 trees have been obtained. Few of these have fruited as yet and no real selections have been made, though many obviously inferior trees have been discarded. This holds true for the open-fertilized seedlings also.

THE PEACH

(1) General improvement, with particular emphasis on quality and attractiveness in the early season, yellow-flesh, freestone varieties.

(2) Extension of the season for peaches of the Elberta type, with earlier and later maturing varieties. This constitutes the main breeding project.

(3) Production of varieties of the yellow-flesh, clingstone type suitable for canning and adapted to Ontario soil and climatic conditions.

(4) Production of white-flesh varieties with good carrying qualities, suitable for overseas shipment.

In the earlier peach breeding work, which was started in 1911, many open-fertilized seedlings were grown, but one only of the parent varieties, the Elberta, produced anything at all outstanding in its progeny. Two selections from the Elberta seedlings, Vedette and Valiant, have been named and introduced. These, with a few other unnamed selections still under test, are the only survivals of well over nine thousand open-fertilized seedlings of various varieties, such as Elberta, Jacques Rareripe, Leamington, Lemon Free, Longhurst, New Prolific, Reeves Favorite, St. John, etc.

A block of Pear seedlings. The main objective of the pear breeding work is varieties resistant to blight.

The later breeding with peaches has been largely confined to definite crosses between varieties and to self-fertilized seedlings of certain varieties and Station hybrids. This phase of the work, inclusive of 1927 breeding, is represented by 350 crosses, giving a total of 3,256 trees. Certain crosses have been particularly productive of promising seedlings. A cross of Vaughan (a selfed seedling of Leamington) with Stark's Early Elberta has given many promising seedlings, one of which, Veteran, has been named and introduced. About one hundred selections of this and other crosses are under test either at the Experiment Station alone or with representative peach growers of the District.

In 1916 the Elberta was crossed with the Arp Beauty. Several of the resulting seedlings showed considerable promise, sufficient to warrant limited propagation and distribution for trial. It is now felt, however, that the later seedlings, including Vedette, Valiant, Veteran and other unnamed selections, are superior to these Elberta x Arp seedlings. Therefore they have never been officially introduced, though a considerable number of bearing trees are now scattered through the Niagara District.

THE PEAR

(1) Blight-resistance in commercially desirable dessert varieties.

While blight-resistance has been the primary consideration when selecting and discarding in the pear breeding work, other qualities desirable in a commercial variety have not been overlooked. The nine selections made thus far are not all necessarily markedly blight-resistant, though showing considerable resistance in most cases insofar as present observation goes. Pear breeding is represented by 4,522 trees, of which 2,608 are, or were, open-fertilized (many have already been discarded) and 1,914 cross-fertilized. One thousand of the latter are still in nursery rows. The pear breeding work was started in 1913.

The six-acre block of Grape seedlings contains approximately 25,000 individual plants from seed. No two plants are exactly alike in all particulars of growth, fruit, season, etc. The "unfit" are removed, the apparently "fit" retained for further trial and observation.

THE GRAPE

(1) Production of varieties of the fruit type of the *Vinifera* or Old World varieties, but possessing the freedom from disease and the climatic adaptability of our present commercial sorts.

(2) Improvement in varieties for wine-making purposes in respect to increase in sugar content and decrease in acidity and in intensity of juice color.

Since the inception of the grape breeding work in 1913, a total of 55,786 seedling vines have been grown. This is exclusive of seedlings still in nursery rows from the 1926 and 1927 work. Of this total, 11,264 were open-fertilized seedlings (seasons of 1913 and 1914). The remaining 44,522 are all from definite crosses, 499 separate parentages being represented. Fifty-five selections have been made from time to time. Most of these selections are now being given a second test with ten to twelve fruiting vines of each. While some of these selections appear to be of considerable promise, they have not yet been sufficiently tested to permit of final judgment.

In the grape breeding work extensive use has been made of varieties possessing *Vinifera* "blood" to a greater or less degree. It is from such varieties, combined with native species, more particularly *Labrusca,* that new varieties of the desired flesh-type, sugar content, acidity, etc., may be expected to be developed.

OTHER FRUITS

In addition to the above fruits, breeding work of a more or less extensive character is being carried on with plums, apricots, black and purple raspberries, currants and gooseberries. These fruits offer as many opportunities for improvement through plant breeding as do the first-named fruits, but, mainly because of their lesser commercial value, they have not been, and are not being worked with to the same extent.

TABLE I. SUMMARY OF FRUIT BREEDING WORK, 1911-1927.

Kind of Fruit	Year Breeding Started	Total No. of Crosses or Parentages to Date, 1927	Total Plants Set Out	No. of Selections to Date	No. of Introductions
Apple	1915	94 crosses 65 open	5,773	....	..
Cherry (1)	1915	22 crosses 27 open	2,027	16	1
Peach	1911	350 crosses and open	12,646	118	4
Pear	1913	98 crosses 39 open	4,522	9	..
Plum (1)	1913	55 crosses 57 open	3,328	4	..
Grape (2)	1913	499 crosses	55,786	55	..
Strawberry (3)	1913	293 crosses	22,171	232	2
R. Raspberry (3)	1913	261 crosses	18,434	126	1
B. & Purple Raspberry	1914	11 crosses	800	....	..
Blackberry	1917	28 crosses	2,000	....	..
Currant (red and black)	1915	21 crosses 20 open	2,240	....	..
Gooseberry	1915	47 crosses 38 open	3,971	21	..
Miscellaneous (Apricot, etc.)					

(1) In cherries and plums many crosses produced no viable seed, hence low number of seed in proportion to crosses made.

(2) Exclusive of 1926-27 breeding.

(3) Exclusive of 1927 breeding.

STATION INTRODUCTIONS

The introductions briefly described below are selections from the earlier breeding work of the Station. In the judgment of the Experiment Station Staff they represent distinct advances in their respective fruits. In fact no seedling is saved, even for preliminary testing, unless it is thought to be *better* in some way than present commercial varieties of the same season. A very few seedlings survive all tests and are thought worthy of extended trial with the grower. These few are officially named and introduced. Some few other seedlings of promise are given limited distribution for trial. These, however, are not named, but are sent out under number, as, for example, peach seedling No. 194055.

VANGUARD STRAWBERRY

(Seedling No. 4304)

Vanguard originated from a cross of Pocomoke and Early Ozark made in 1913. It is a good, though not an excessive plant maker. Plants are vigorous, healthy and productive. Flowers are perfect. In season Vanguard is early, the first fruits ripening about with Premier or Howard 17. The fruit is of medium size, round-conic, regular in shape, color bright red and quality good, being sweeter than most early varieties. The berries are firm and ship well. The fruit holds its size well throughout the season, late pickings being of good size.

Vanguard Strawberry, promising as an early season strawberry. It seems to be particularly adapted to the heavier strawberry soils.

Vanguard has now been sufficiently planted in strawberry-growing areas to enable the formation of at least tentative opinions as to its commercial value as an early season berry. With some growers the variety has stood up well and is well liked. With others reports have not been favorable. In analysing these varying reports it appears that Vanguard is most successful on what might be termed the heavy strawberry soils. This does not imply that the variety is suited to really heavy soils in the ordinary meaning of the term. On quite light soils Vanguard has failed to show the same promise.

Vanguard was officially named and introduced in 1922. It was first sent out for trial in 1920 under the name Vector, when 150 plants were distributed, 25 each to six growers. Subsequent distributions were made each year from 1922 to 1928. In all over twelve thousand plants have been distributed direct from the Experiment Station, these plants going out to 225 growers, experiment stations, etc. The variety is now listed by several Ontario nurseries as later noted.

VANDYKE STRAWBERRY

(Seedling No. 19322)

Vandyke originated in 1919 as an open-fertilized seedling of Station seedling No. 1467. No. 1467 was from a cross of Dunlap and Early Ozark. Vandyke is a vigorous grower, a good runner maker and an excellent yielder. Flowers are perfect. In season Vandyke is early, the first fruits ripening a day or two in advance of Vanguard and Premier. The fruit is wedge-conic in shape, of very fair quality, medium red in color, moderately firm only. Its chief value is likely to be as an early berry for local markets.

In 1928 there were indications of the variety being affected by a virus disease. Further test is necessary to determine whether this is a varietal weakness or whether it is a controllable disease.

Except for these indications of disease, Vandyke, in limited tests, has given exceptional promise as an early market berry. The variety seems to be adapted to a much greater range of soils than Vanguard, doing equally well in 1917 on light sandy soil, sandy loam and clay loam.

Plants of Vandyke were first distributed for trial, under number (19322), in 1924. Subsequent distributions were made each year up to the present, though a total of less than 1,000 plants in all have been sent out. Distribution from the Station has been light owing chiefly to the fact that small fruit nurseries quickly built up a stock of plants for sale, thus obviating the necessity of distribution by the Station.

VIKING RED RASPBERRY

(Seedling No. 14038)

Viking originated from a cross of Cuthbert and Marlboro made in 1914. In plant characters, growth habit, etc., Viking appears to be outstanding. It is a vigorous grower, producing a moderate number of tall thick canes which are of such strength that they remain upright when loaded with fruit. This means much in cleanliness of fruit, ease of picking, late cultivations and other cultural operations during the picking season. The canes are almost entirely free of spines, which also facilitates fruit picking. Yield is equal to or better than Cuthbert. In season Viking starts just in advance of Cuthbert.

Viking Red Raspberry (reduced).

In fruit characters Viking is as large or larger than Cuthbert, is firmer than that variety and therefore holds up better under shipment. This firmness, together with the bright lively red color of the fruit,

Canes of Viking Raspberry, illustrating straight, sturdy growth and complete absence of spines.

probably accounts for the preference being given Viking on the fresh-fruit market. On the other hand the deep color of the Cuthbert probably gives it the preference for canning and jam-making. In quality Viking is intermediate between the two parent varieties, Cuthbert and Marlboro.

Viking has been widely disseminated since it was introduced in 1923. Its performance under varying conditions of soil and climate has been almost uniformly good, so that it can now be recommended generally for commercial planting. Viking seems to have won the favor of growers because of its excellent plant habits, and the favor of markets because of the appearance of the fruit. Also the variety is proving particularly hardy and promising in other ways in the colder raspberry sections of Ontario and the province of Quebec.

To the commercial grower yield is of paramount importance. Unfortunately, accurate comparative yield records are not available from the Experiment Station plantation. The following figures, supplied by Prof. T. G. Bunting of Macdonald College, are therefore of more than ordinary interest. The experiment in question was conducted on the grounds of the Horticultural Department, Macdonald College, Quebec:

(Courtesy of Horticultural Department, Macdonald College, Que.)

Viking Raspberry canes, planted May, 1924, photograph taken May 9, 1928.

TABLE 1A—COMPARATIVE YIELDS OF VIKING AND HERBERT RASPBERRIES UNDER DIFFERENT PRUNING SYSTEMS:

Plot	Variety	No. of Canes left	Height, feet	Actual Yield, pints	Estimated Yield per acre, pints
1	Viking	100	5¼	59	9646
2	"	100	tipped only	56	9156
3	"	100	4¼	51	8336
4	"	55	tipped only	42	6867
5	Herbert	110	4½	24	3924
6	"	110	tipped only	22	3597
7	"	110	3½	23	3760
8	"	60	tipped only	21½	4006

(Courtesy E. D. Smith & Sons, Winona)
Nursery block of Viking Red Raspberry plants.

In discussing the above experiment Prof. Bunting writes as follows: "The height of the canes before pruning and thinning out would range from 6 to 8 feet for the Viking and 5½ to 6 feet for the Herbert. For this reason 10% more canes were left in the Herbert plots. In tipping the canes only the dead or dried parts at the tip were removed. All plots were trellised with two wires strung about 3½ feet high and twelve inches apart. On account of the length of canes left in plots 1, 2, 4, 5, 6 and 8, the ends of the canes were bent over and interwoven on the wires.

"Two other rows of Viking 380 feet long, planted in the spring of 1927, yielded in the second season, 1928, at the rate of 2,293 and 1,544 pints per acre respectively, the latter yield being from the outside row, which, in part, accounted for the smaller yield."

Since its official introduction in 1923, plants have been distributed from the Station in excess of 63,000 in number. The bulk of these were sent out in 1925 and 1926. Subsequent distributions have been confined almost entirely to points outside the province, and experiment stations. Other distribution has been taken care of in a normal way by growers and nurseries. The extent of nursery distribution is noted in Table III.

VICTOR SWEET CHERRY

(Seedling No. 160138)

Victor is an open-fertilized seedling of the Windsor variety, being one of the selections from the earlier cherry breeding work (1916). Several other selections of the same parentage have been made, but, thus far, Victor is the only one to be named. The other selections are still under test at the Experiment Station and with a few growers.

Victor is a white-fleshed cherry of the Napoleon type and external coloring. The fruit is large, firm-fleshed, of good quality and very attractive in appearance. The pit is small for the size of the fruit. There is some doubt as to the exact season of the variety. In its earlier fruiting years the original seedling tree matured its fruit in Governor Wood season.

Victor White Sweet Cherry.

On this account, and taking into consideration firmness of flesh, larger size and better appearance, Victor appeared to be a distinct improvement on Governor Wood for a white cherry of that season. However, during the past three or four seasons, Victor has seemed to mature its fruit somewhat later than indicated above, being only slightly in advance of Napoleon itself. Final judgment as to season will have to be delayed until budded trees come into bearing.

In 1928 there was some indication too that Victor fruit buds might occasionally fall short in hardiness. On this account, but more particularly because of uncertainty as to season, Victor is recommended for trial only at the present time.

Approximately eighty trees of Victor have been distributed from the Station for test purposes, most of these being sent out in 1925. In addition, the variety is being propagated in a limited way by two Ontario nurseries. Dissemination of the variety, therefore, has been ample to insure a thorough test. Further dissemination should probably be light until more is known as to its value.

VAUGHAN PEACH

(Seedling No. 131617)

Vaughan originated in 1913 as a self-fertilized seedling of Leamington. Leamington itself, a hardy white-flesh variety, originated in the Leamington District, Essex County, Ontario, as an open-fertilized seedling of Tyhurst, the pollen parent being probably a white-fleshed variety. Leamington is little known or grown outside of Ontario, and is valuable chiefly because of hardiness and sure cropping.

Vaughan is a yellow-flesh variety. It inherits the hardiness and heavy cropping characters of its parent variety, excelling in bud-hardiness any other yellow-flesh variety so far tested at this Station. It was named and introduced mainly on this account, though the fruit itself is attractive in appearance and of good size and quality. In general fruit characters Vaughan somewhat resembles Rochester in appearance, though of brighter color. It is a semi-free to freestone, maturing with, or just in advance of Rochester.

Vaughan has never been propagated to any extent by nurseries, though a considerable number of trees have been planted in the Niagara District. These were propagated for the most part by growers themselves who liked the variety and who found it profitable on account of its season and its certain cropping. The variety was sent out for trial under number (131617) and was not named until 1925, when the number of trees planted in the District suggested the advisability of officially naming and introducing it.

VEDETTE PEACH

(Seedling No. 150369)

Vedette is an open-fertilized seedling of Elberta from seed saved in 1915. Judging from fruit and tree characters it is almost certain that Vedette is a self-fertilized seedling of Elberta. It was officially named and introduced in 1925, though some distribution of nursery stock for trial purposes had been made prior to that year.

(Courtesy Col. H. L. Roberts, Grimsby)

Vedette, an Elberta type Peach ripening in St John season.

Vedette closely resembles the parent variety, Elberta, in general appearance, size, flesh-type and color. It is, however, more globular in shape, possibly more highly colored, and is of better quality. It is, of course, a yellow-flesh freestone. In season Vedette matures approximately three weeks in advance of Elberta, or about with St. John. In tree characters Vedette appears to be healthy, hardy, vigorous and an early and productive bearer. The probable value of Vedette lies in the fact that it is a peach of the Elberta type, apparently possessing many of the good qualities of that variety, but maturing at a much earlier date.

The earlier plantings of Vedette bore fruit in 1927 and 1928. The variety seems to have caught the fancy of the grower, as, for a new variety, plantings have been heavy during the past two years. In all

A branch of Vedette Peaches in the orchard of Mr. Jas. Taylor, Beamsville.

approximately 15,000 trees had been set out up to and including 1928. Ontario nurseries have on hand for 1929 spring delivery 13,500 trees and further estimate that for 1930 they will have 25,300 trees.

In canning tests, in British Columbia as well as Ontario, Vedette and Valiant have attracted favorable comment. In British Columbia Vedette seems to have had the preference in this particular, while in Ontario the difference, if any, has been in favor of Valiant.

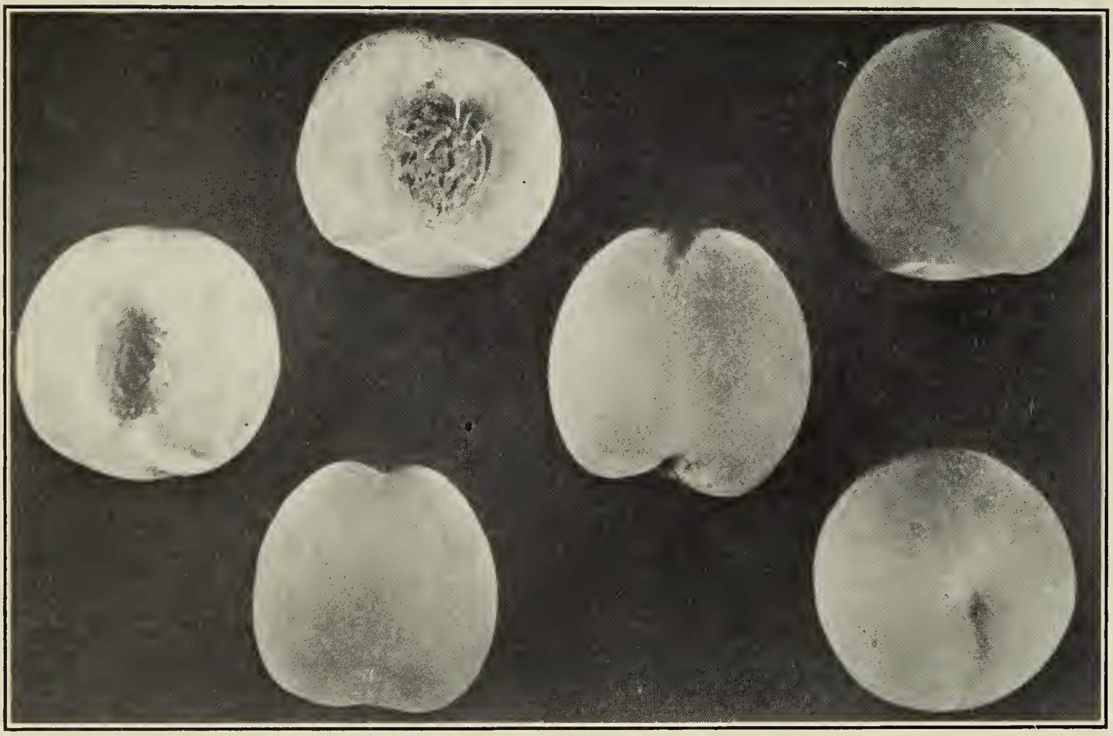
A block of Vedette Peaches in the orchard of C. Howard Fisher and Son, Queenston.

VALIANT PEACH

(Seedling No. 174770)

Valiant originated from open-fertilized seed of Elberta saved in 1917, or two years later than Vedette. Also, as in the case of Vedette, there is every indication that Valiant is, in reality, a selfed (self-fertilized) seedling of Elberta. Valiant was officially named and introduced in 1925.

Valiant, like Vedette, is an Elberta type peach. It is more highly colored than Elberta, more globular in shape and of undoubted better quality. Flesh color is an attractive rich yellow, usually freestone. In season Valiant matures from a few days to a week after Vedette. Tree habits are good though growth may be more moderate than with Vedette, which is apparently a very vigorous grower. Vedette and Valiant are easily distinguishable at blooming time, Vedette being of the large-bloom type and Valiant the small type.



Valiant, also an Elberta type Peach, but maturing 4 to 6 days later than the Vedette.

While it is early as yet to judge, there was some indication in 1928 that Valiant is somewhat hardier in bud than Vedette, though Vedette is not noticeably tender by any means. Valiant will likely carry heavier crops, on the average, than Vedette, and will probably require thinning, in some seasons at least, to insure proper development of fruit. However, growers should not plant one variety in preference to the other, inasmuch as they are of different season and therefore supplement each other.

Young trees of Valiant fruited in considerable quantity in 1927 and 1928, especially the latter year. Extensive commercial plantings are indicated by the following nursery figures. Sales of nursery stock up to and including 1928 approximated 3,800 trees. Stock on hand for 1929 delivery amounts to 5,000 trees, while nursery estimates of stock which will be available for 1930 total 17,200 trees.

Three year old Valiant tree in fruit, orchard of Mr. Jas. Taylor, Beamsville.

VETERAN PEACH

(Seedling No. 1940208)

Veteran originated from a cross of Vaughan (Station seedling No. 131617) and Stark's Early Elberta. The cross was made in 1919 and the seedling tree eventually named Veteran first fruited in 1925. While not as thoroughly tested as Vedette and Valiant, yet Veteran has shown such promise from the start that it was thought advisable to introduce the variety and distribute trees for test purposes at the earliest possible date. This was done in 1928, about 650 trees in all being sent out.

Veteran is another Elberta type peach, its season being midway between Valiant and Elberta. With Vedette, Valiant and Elberta, therefore, it gives a season of practically one month of Elberta type varieties, maturing in the order named, Vedette, Valiant, Veteran and Elberta.

While Veteran possesses undoubted Elberta characteristics, it is practically globular in shape, even exceeding Vedette and Valiant in this respect. Because of this globular shape all three varieties are more attractive in appearance than Elberta. The fruit of Veteran is large, yellow-flesh, freestone, superior to Elberta in quality. Tree characters appear to be good, though rather early to judge as yet.

Considering the limited trial to date, Veteran is being propagated in quite sufficient quantity. Nursery records show 2,000 trees on hand for delivery in the spring of 1929 and estimates of 7,500 trees for 1930. 650 trees have already been planted out as previously noted.

Finally, with respect to the various new varieties of peaches introduced by the Horticultural Experiment Station, one or two observations may be permitted. In the peach breeding work the main objective has been to secure a seasonal succession of peaches of the Elberta type. In this objective, it is recognized that, whatever its faults, the Elberta is nevertheless the outstanding commercial variety and type, and therefore

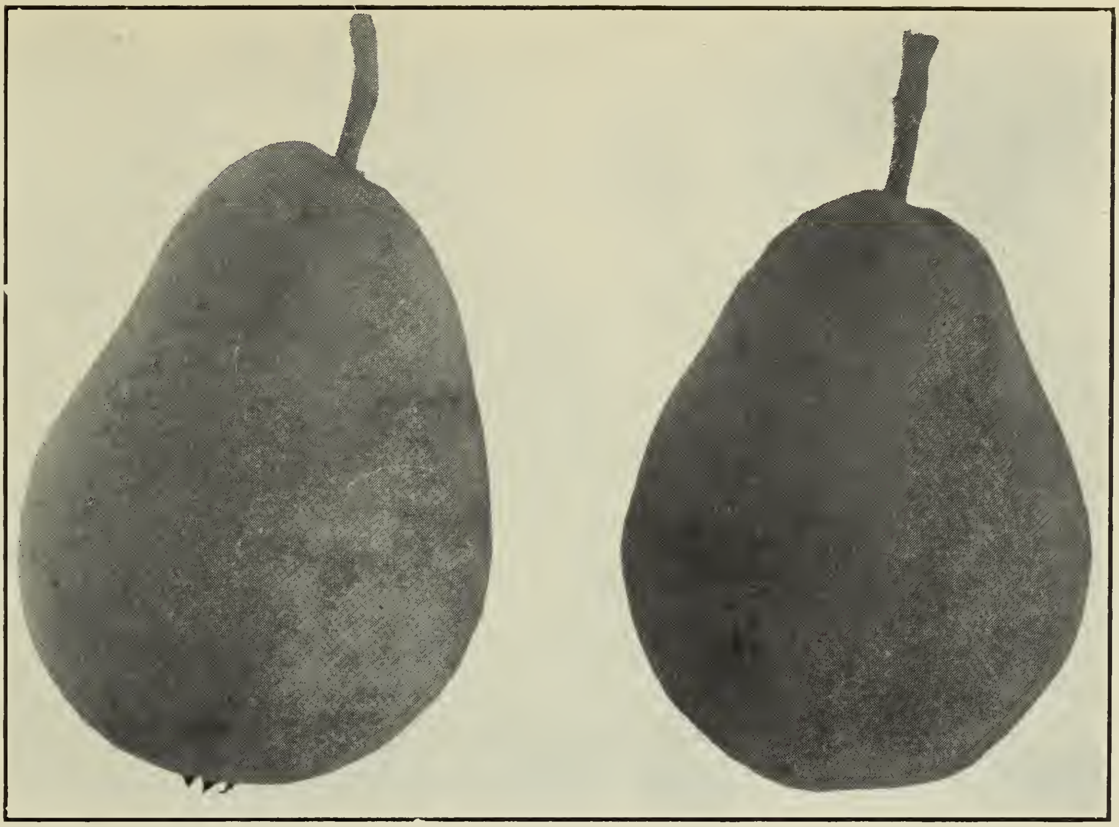
Veteran Peach, Elberta type, but maturing about a week in advance of that variety.

a logical starting point in variety improvement. It is hoped that the objective sought, an extension of the Elberta season, has been partially reached in the origination and introduction of Vedette, Valiant and Veteran. These varieties, however, should be planted with caution, as weaknesses not now apparent may later be evident in one or more of them. All that one can now say is, that they have been selected with the greatest care, that they have been tested as thoroughly as their recent origin will permit, and that they appear to be superior to present commercial varieties of the same season.

RUSSET BARTLETT PEAR

This pear originated as a bud-sport on the farm of N. P. Moyer and Son, Jordan Harbor. Examination of the parent Bartlett tree and of the "sport" branch show conclusively that it is a true bud-sport. The russet fruits were first brought to the attention of the Experiment Station in 1918. The following year grafts were secured from the russet-fruited branch and were inserted on a Bartlett tree in the Station orchard.

These grafts have been bearing fruit since 1922. These fruits, and the fruit from the parent bud-sport, are typical Bartlett fruits in all particulars save in the complete and handsome russeting of the skin, and also perhaps in season and keeping quality. Similar sports of the Bartlett as to russet color have been noted by other observers in the states of New York and Michigan, and probably elsewhere. This particular sport, however, while essentially Bartlett, seems to differ slightly from that variety in one or two particulars besides color. It hangs to the tree better.



Russet Bartlett Pear, a russet-coloured bud-sport of the ordinary Bartlett.

than Bartlett, even after mature, is a few days later in maturity, retains its quality longer if left hanging and, after picking, keeps for a longer period in ordinary storage.

Entirely apart from the russet coloring, therefore, this Bartlett bud-sport was thought to have sufficient merit to warrant distribution for trial purposes. Accordingly, a number of trees were propagated and were sent out by the Experiment Station in 1927. Possibly the variety should not be further propagated or disseminated until these trees have come into bearing and confirmed or otherwise the present opinion of its merits. This Russet Bartlett sport, while not an origination of the Horticultural Experiment Station, is being introduced by the Station with the permission of N. P. Moyer and Son.

TABLE II.—STATION DISTRIBUTION OF NEW VARIETIES

	Plants distributed (by years)							
Variety	1922	1923	1924	1925	1926	1927	1928	Total
Vanguard Strawberry	300	330	425	3000	6750	1150	300	12255
Vandyke "	......	......	100	50	100	475	175	900
Viking Raspberry	......	36	1532	38495	17520	4275	1617	63475
Victor Cherry	......	......	....	50	9	19	....	78
Vaughan Peach	......	......	60	....	....	....	....	60
Vedette Peach	......	14	100	400	....	....	....	514
Valiant Peach	......	......	100	300	....	....	....	400
Veteran Peach	......	......	....	....	....	55	....	55

TABLE III.—NURSERY DISTRIBUTION OF NEW VARIETIES

Variety	No. of Plants sold previous to fall of 1928	Stock on hand for 1928-1929	Estimated stock for 1930
Vanguard Strawberry	25,000	23,000	78,000
Vandyke "	6,000	20,000	80,000
Viking Raspberry	50,000	84,000	160,000
Victor Cherry	150	285	500
Vaughan Peach	1,100	1,000	2,000
Vedette Peach	15,000	13,500	25,300
Valiant Peach	3,800	5,000	17,200
Veteran Peach	650	2,000	7,500

The distribution of tree fruits, as given in Table III., may be considered as fairly accurately representing the dissemination of these varieties. Nurseries constitute the chief means of propagation and distribution. For strawberries and raspberries, however, the situation is entirely different. While it is true that the nurseries handle considerable quantities of plants of these fruits, yet many times this number pass from grower to grower, or are retained by the owner for increased plantings of his own. It is therefore impossible, short of an extensive survey, to estimate present or near future plantings of these fruits. The nursery figures, as given above, must be taken as merely indicative of present plantings of strawberries and raspberries.

NURSERIES LISTING STATION INTRODUCTIONS

For the convenience of growers and others who desire to purchase stock of the various new varieties of fruits described in this bulletin, the following list of Ontario nurseries is given. This list is complete according to present records.

Vanguard Strawberry—H. C. Downham Nursery Co., Strathroy; Ed. Lowden, Hamilton; Freeburne Bros., Hamilton; Wm. Julian, Fenwick; E. D. Smith & Sons, Winona.

Vandyke Strawberry—Ed. Lowden; E. D. Smith & Sons.

Viking Raspberry—Geo. Adams, Smithville; Brown Bros. Co. Nursery Ltd., Ridgeville; McConnell Nurseries, Port Burwell; E. D. Smith & Sons; W. S. VanEvery, Welland; Wellington & Davidson, Fonthill.

Victor Cherry—E. D. Smith & Sons; Wellington & Davidson.

Vaughan Peach—A. Roszell, Fonthill; W. S. VanEvery.

Vedette Peach—Brown Bros. Co. Nursery Ltd.; H. C. Downham Nursery Co.; Wm. Julian; A. Roszell; E. D. Smith & Sons; Jas. Taylor, Beamsville; W. S. VanEvery; Wellington & Davidson.

Valiant Peach—Brown Bros. Co. Nursery Ltd.; H. C. Downham Nursery Co.; Wm. Julian; E. D. Smith & Sons; Jas. Taylor; W. S. VanEvery; Wellington & Davidson.

Veteran Peach—H. C. Downham Nursery Co.; E. D. Smith & Sons; Jas. Taylor; W. S. VanEvery; Wellington & Davidson.

PROMISING STATION SEEDLINGS NOT YET INTRODUCED

In all our commonly grown fruits, seedling selections of promise are being given careful test. As previously indicated, those named and introduced represent the earlier breeding work. Selections from later breeding are of equal or greater promise and will be introduced as soon as they have been sufficiently tested. A few of these, of particular interest and promise, are herewith listed with brief descriptive notes.

SWEET CHERRIES

No. 160133—An open-fertilized seedling of Windsor. Fruit large, firm-fleshed, same color as Windsor. Tree vigorous, productive, season of Windsor. Twenty-one trees distributed for test in 1926 and 1927.

No. 160140—Open-fertilized seedling of Windsor. Fruit large, dark in color, moderately firm, attractive appearance with a rich, "mahogany" finish. Fruit stem long. The fruit is relatively free from splitting and cracking in wet weather. Tree is moderately vigorous. Season of Windsor. Twenty trees were distributed for test in 1927.

No. 160145—Open-fertilized seedling of Windsor. Fruit of large size, black, moderately firm, attractive in appearance. Tree vigorous, productive. Ten trees were distributed for test in 1927.

No. 160323—Open-fertilized seedling of Napoleon. No. 160323 is a white cherry, blushed red. It matures in Governor Wood season, but is larger than that variety, of better quality and more attractive in appearance. Also the fruits will hang on the tree for a long time after maturity without deterioration. Tree vigorous, productive. Eight trees are under test at the Experiment Station, but none have been distributed to growers for test.

PEACHES

No. 19141—A self-fertilized seedling of Station seedling 13065 (Early Crawford x Greensboro), No. 19141 is a peach of the California canning type—tough or rubbery flesh, clingstone. The fruit is of good size, maturing in early mid-season. Suitable for canning only.

No. 194049—This seedling, and the two next to be described, are from a cross of Vaughan (Station seedling No. 131617) and Stark's Early Elberta, the former being the seed parent. No. 194049 is an Elberta type peach, but maturing in St. John season. The fruit is large, more globular than Elberta, yellow-flesh, freestone. In one or two seasons the flesh of the fruit has seemed to lack sufficient firmness and juiciness, otherwise good in every way.

No. 194055 (Vaughan x Early Elberta)—Also an Elberta type peach, though distinctly more globular than Elberta and maturing three weeks earlier. The fruit is large and handsome in appearance, yellow-flesh, freestone. The flesh is fine-grained, of excellent deep color and good quality. This seedling is probably the equal of Vedette and Valiant in every respect and may prove superior. However, since it is practically the same season as Vedette, it has not yet been distributed except for test purposes. If it eventually proves superior to Vedette it will be named and introduced.

No. 1940149 (Vaughan x Early Elberta)—An Elberta type peach, closely resembling that variety in all fruit characters except season of maturity, which is about three weeks earlier. This seedling apparently possesses greater hardiness of fruit-bud than the Elberta and similar type peaches. The parent seedling tree has borne excellent crops every year since coming into bearing in 1923. The fruit is yellow-flesh, freestone and of good quality.

No. 194199—This seedling, a particularly high quality, white-flesh variety, is from a cross of two Station seedlings, No. 11041, an open-fertilized Elberta seedling, and No. 13061, a cross of Early Crawford and Greensboro. The fruit of No. 194199 is medium to large in size, attractively blushed, white-flesh, freestone and of exceptional quality.

No. 202364—This seedling is from a cross of Station seedling No. 11041 (an Elberta seedling) and Arp Beauty. The fruit is globular, of good size and appearance, yellow-flesh, freestone. Season of maturity is 4-6 days after St. John. Tree vigorous, productive.

PEARS

No. 14019—This seedling and No. 140127, which is next described, are open-fertilized seedlings of a tree found growing wild near Vineland. This wild tree, though bearing fruit of no particular commercial value, seemed to be resistant to pear blight and on this account a considerable quantity of its seed was collected and grown. The fruit of No. 14019 resembles that of the Clapp's Favorite in appearance and also in quality. It does not decay at the core as does Clapp's Favorite, however. The flesh is fine-grained and of an excellent clear white color. The original tree is now very large, has borne fruit since 1924, and shows little blight in spite of every opportunity for infection. In this connection it might be mentioned that, as blight resistance is the main consideration in the pear breeding work, the disease is encouraged to spread in the seedling orchards. Heavy growth is stimulated, and many diseased trees are left to act as sources of infection.

No. 140127—This is a sister seedling of No. 14019. The fruit of No. 140127 is attractive in appearance when mature, though much like Keiffer in shape. Fortunately, its resemblance to Keiffer does not go further. The fruit is of moderate size, very firm-fleshed, but fine-grained, juicy and of fair quality. Season about with Bartlett. This seedling is chiefly notable, however, for the keeping qualities of the fruit. The fruit seems to mature and ripen equally as well on the tree as off, being fine-grained and juicy when tree-ripened. The fruit hangs well to the tree. Furthermore, the fruit at ordinary room temperatures remains in a fully edible condition for many days, 15-20, after being soft-ripe. Such fruits finally start to decay in a very restricted area, around the core only. The very firm, almost tough, flesh of this pear and its moderate quality only, may rule it out as a dessert variety. On account of flesh characters, however, it would seem to have considerable promise for canning factory purposes. The original tree has never yet shown blight, though bearing regularly since 1924. This seedling is under test at Experiment Stations at Summerland, B.C., and Ridgetown, Ontario, as well as at Vineland.

No. 150428—From a cross of Bartlett x Bosc. The fruit is of large size, resembles Bosc in shape, but is bright yellow in color. The fruit is of fair quality although the flesh is inclined to be somewhat dry. This seedling is being tested at the same Experiment Stations as seedling No. 140127, no trees having been distributed for general test as yet.

GRAPES

No. 132860—An open-fertilized seedling of Aminia. Bunch is medium in size, berries medium to small, almost black in color. Flesh type resembles *Vinifera* varieties. Quality good, rich, vinous.

No. 16033—Campbell x Winchell. Bunch of medium size and compactness. Berries medium to large, black, fair to good in quality. Early season, ripening with Moores Early; productive.

No. 16357—A Brighton x Campbell seedling. It is a medium size blue grape, medium size bunch. Promising on account of flesh type, which resembles that of the *Vinifera* or European grape.

No. 17096—Herbert x Campbell. Bunches and berries of good size, attractive, blue. Quality rich, good, vinous, mid-season.

CHANCE SEEDLINGS UNDER TEST

What might be termed a phase of the plant breeding work is the testing of chance seedlings sent in by fruit growers and others interested in plant improvement. Many such seedlings have been received from time to time. Most of them possess considerable merit and are deserving of careful test and observation. The following is a list, possibly not complete, of seedlings sent in for test:

Nature of Seedling	Year Received	From Whom Received
Apple, White, sweet	1925	N. C. Butler Nixon, Ont.
Apple, Red, Early Winter	1914	A. H. Culp, Vineland Sta.
Apple, Red	1925	W. Casey, Mitchell, Ont.
Apple, Astrachan type, larger	1923	C. A. Fleming, Owen Sound
Apple, large red Fameuse	1924	A. E. Howell, Fenwick
Apple, Red, scab resistant?	1923	Chas. M. MacFie, Appin
Apple, Red winter, "Norval"	1925	L. H. Laird, Norval
Apple, probably Fallawater	1921	Geo. H. Ramsay, London
Apple, ?	1923	Unknown, Simcoe
Apple, Fameuse type	1921	F. G. Stewart, St. Catharines
Cherry, Large Montmorency type	1927	A. Roszell, Fonthill
Cherry, Sour	1922	John Bartlett, Oshawa
Cherry, Large, sour	1914	W. J. Fisher, Grimsby
Peach, Yellow, mid-season	1922	W. P. Biggar, Jordan
Peach, Crawford type	1922	H. B. Bowman, Kitchener
Peach, 7 Elberta type seedlings	1916	Mr. Caverley, Toronto
Peach, Crawford type	1919	A. H. Culp, Vineland Sta.
Peach, ?	1923	Dr. D. Davidson, Woodstock
Peach, White flesh, late	1916	Mr. Delamere, Toronto
Peach, Yellow, "Bonnie"	1926	W. V. Hopkins, Burlington
Peach, Yellow, free	1918	H. L. Hutt, Georgetown
Peach, hardy	1926	Dr. M. D. McKichan, Toronto
Peach, late yellow	1923	A. J. Painter, Hamilton
Peach, Smock type	1920	T. B. Revett, Niagara-on-the-Lake
Peach, Yellow, "Perfection"	1926	A. Roszell, Fonthill
Peach, early, yellow, "Baxter"	1926	Jas. Taylor, Beamsville
Pear, Large, late	1928	Dr. F. J. Farley, Trenton
Pear, Resembles Clapp's, early	1926	J. E. McCombs, Fenwick
Plum, ?	1923	J. R. Berney, Owen Sound
Plum, resembles Coe's, earlier	1922	John Bartlett, Oshawa
Plum, Blue, attractive	1922	John Bartlett, Oshawa
Grape, Blue, "Lincoln"	1916	W. Read, Port Dalhousie
Grape, Blue, "Patricia"	1917	W. Backus, St. Catharines
Grape, Amber-colored	1924	W. Backus, St. Catharines
Grape, Red	1924	W. Backus, St. Catharines
Grape, Red	....	D. Jamieson, Hamilton
Grape, Red, Concord season	....	W. Ellis, Stamford
Grape, Red	....	H. L. Culp, Beamsville
Grape, Blue, Lindley "sport"	....	A. Bater, Beamsville
Grape, Amber	1926	S. Kratz, Jordan Sta.

These seedlings remain the property of the individuals sending them in. No plants, bud-wood, cuttings, etc., are sent out by, or allowed to be taken from the Experiment Station without the consent of the originator. The function of the Station is simply to test out these seedlings under conditions favorable for observation and comparison with present commercial varieties, and to eventually give to the originators an opinion as to their merits.

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The More Important Fruit Tree Diseases of Ontario

By J. E. HOWITT, Professor of Botany, and
LAWSON CAESAR, Professor of Entomology.

INTRODUCTION.

The object of this bulletin is to furnish all who are interested in fruit growing with information which will enable them to identify the more common diseases of fruit trees and to apply successfully the treatments which experiments and observations extending over a period of eighteen years have shown to be the most effective in each case.

WHAT FUNGUS DISEASES ARE.

The majority of the diseases of fruit trees are what are known as fungus diseases. It is important that those having to deal with them should understand fully the causes of such diseases, in order that they may apply intelligently, remedies for their control. Fungus diseases are caused by plants known as fungi. These plants, unlike ordinary flowering plants, have no green colouring matter (chlorophyll), and are unable therefore to manufacture their own food. All their nourishment must be obtained from decaying animal or vegetable remains or from living animals or plants. Those fungi which derive their nourishment from living plants in so doing injure them in various ways and thus give rise to what are known as fungus diseases.

The bodies of fungi which cause plant diseases are usually very simple, consisting of very fine, delicate, thread-like structures (hyphæ), some of which become modified and produce reproductive bodies called spores, which may be considered similar to the seeds of flowering plants. Sometimes the fungus threads live upon the surface of the plants and obtain their nourishment by sending down little suckers (haustoria) into the cells below. Most frequently, however, they live within the plants, either in or between the cells. Two kinds of spores are frequently produced—thin-walled summer spores, which spread the organism during the growing season, and thick-walled resting or winter spores, which serve to carry it over the winter. Spores are scattered by various agencies, chief among which are wind, water and insects. On coming in contact with a suitable host plant they send out little threads (germ-tubes), which enter the plant through the breathing pores on the leaves (stomata), through the skin or through wounds. Once within the plant the little threads grow very rapidly, drawing their nourishment from the cells of the host plant and setting up a diseased condition.

Generally speaking, in combating fungus diseases, methods of prevention only are practicable. Once a fungus is within the plant nothing can be done to destroy it. Spraying with lime-sulphur, Bordeaux mixture or other fungicide is not done to cure but to prevent disease. In other words, the object of spraying is to cover the surface of the leaves, fruits or other parts of the plant with a substance poisonous to the spores of fungi, in which they cannot grow and penetrate the plant. Spraying, therefore, in order to be effective, must be timely and thorough. The spray mixture must be on the tree before the spores reach it and the surface of the leaves, fruit and other parts of the plant must be completely covered so that there is not the smallest space on which a spore can germinate.

SPRAY OUTFITS.

Those who purpose buying spray outfits and spray material can find the addresses of the various manufacturers by looking over the advertisements in the agricultural and horticultural journals.

If there are only a few trees to spray, such as one finds in a backyard in a town, a small hand pump, holding five to ten gallons of liquid, will suffice. This should be equipped with about twenty-five feet of good hose and an eight-foot bamboo pole with an angle-disc nozzle. Such an outfit costs from $20.00 to $30.00.

In small orchards of about three acres of moderately large apple trees, or of about six acres of plum or cherry trees, it is possible to do good spraying with a barrel pump of forty gallons capacity. This should be equipped with twenty-five or thirty feet of good hose and an eight-foot bamboo rod with two angle-disc nozzles on a V. This kind of outfit will cost from $35.00 to $60.00.

For all larger orchards hand outfits are too slow and therefore gasoline power machines should be used. There are many kinds of these, some adapted for small orchards and some for large. The cost varies with the power and size of the outfit and runs from about $300.00 up to about $900.00. All power outfits are equipped with either single or double guns according to the wish of the purchaser. Double guns are not satisfactory unless the machine will maintain constantly a pressure of 300 lbs. At this pressure they are preferable to single guns, because they cover the trees much more quickly and are less likely to burn the foliage. Single guns are well adapted to pressures of from 200 to 300 lbs., but not for any pressure less than 200 lbs. At high pressures they send so forcible a spray that unless carefully operated they are likely to cause serious burning.

In many cases, instead of buying two guns, it is wise to purchase one gun and a seven or eight-foot bamboo pole, equipped with two or even three angle-disc nozzles. The pole and nozzles give a much finer spray and cover a wider area at a time than a gun, especially a single gun. Hence a poor sprayer is likely to do a better job when spraying with the wind with a pole than with a gun. The pole and nozles are not so well adapted as the guns for spraying against the wind or even partly against it.

If the trees are thrifty and over fifteen years of age it is almost always wise to have a support on the top of the tank so that one man can spray from it and thus be able to use a finer spray and yet cover all the top of the tree with ease. The simplest and most convenient kind of support can be made easily, and consists of a 2 x 4 inch piece of timber about the length of the cover of the tank, and supported by two legs at or near each end as on a sawhorse. Each pair of legs should be firmly mortised into a board and then the board screwed on the top of the tank. This makes it possible to remove the whole support when necessary. The operator stands straddle of this sawhorse support and so can move about freely without danger of falling. Moreover, this sort of support being directly over the centre of the tank enables it to pass between large trees without catching the branches.

Good care of any outfit is absolutely essential, otherwise it may last only a single season. If, however, it is kept well oiled and in good working condition, is washed out at the end of every application, or better still, at the end of every day‘s work, and, if, before putting it away for winter at the end of the spraying season, all water is drained off and all parts likely to corrode are well oiled, and oil pumped through the cylinders of the pumps, it should last for many years.

SOME SUGGESTIONS ON SPRAYING.

Most of our good growers are getting from 90% to 99% of absolutely clean fruit every year. This should be the aim of every fruitgrower, otherwise he will not secure the maximum benefit from the work he puts on spraying. But no one will secure such a percentage unless he does good, thoughtful work. The following suggestions will help him towards this goal.

(1) Every spring before the season opens see to it that the spray outfit is thoroughly overhauled and tested to make sure that it is working well and giving good pressure.

(2) Have all spray materials ordered up and on hand several weeks before the spraying operations begin so that there will not be an hour's delay when the time arrives.

(3) Have a convenient place for filling the tank rapidly. Ten minutes are long enough to fill even a 200-gallon tank. Have also scales, measures and materials arranged in a handy manner, so that there may be no waste of time in getting these into the tank.

(4) In an emergency, especially where rain is threatening, do not hesitate to work overtime, even though you have to pay your helper extra for doing so. An hour or two of spraying just before a wet spell may save you hundreds of dollars by keeping off scab from apples or rot from cherries or plums.

(5) Get a spray calendar and follow as closely as you can the instructions given there for each kind of fruit.

(6) Remember that the timing of the sprays is just as important as the thorough covering of the fruit and foliage. The times stated in the spray calendar are as nearly right as our knowledge can make them, and, if each application is given just at the time indicated, it will always or almost always protect the fruit until the next one is due; but if one spray is omitted or given at the wrong time and the weather in the meantime becomes wet, apple scab or brown rot or whatever disease is threatening may get a start and no later spraying will be able to atone for the mistake.

(7) In spraying aim at covering every part of the fruit or foliage thoroughly. On large trees this is not easily done and requires much care and systematic work. Do not forget that it is always the side of the fruit which is most shaded, that is the side which points towards the centre or trunk, which is most likely to be attacked by disease. Hence see that you spray everything from the side you are working on right through to the other side. Then when doing the opposite side of each row keep this same aim in view. Another important part of the tree likely to be poorly sprayed

is the top, so when doing this hold the spray a little longer on it than on the lower parts and see that it also shoots over the top and falls down on the other side. Standing on a tower or on the tank helps of course in the case of tall trees.

Sometimes after the orchard has been sprayed from one side the wind fails to change and yet threatening rain or the stage of the fruit makes it necessary to get the spray on the other side at once. In such cases it is often possible to get over the difficulty by starting earlier in the morning or spraying after supper when the wind has gone down. When this cannot be done the difficulty can usually be overcome fairly well by driving straight into the wind and shooting the spray in at right angles to it from one side. Then come back again and go up the other side of the trees against the wind and shoot the spray in at right angles from this side also. This means spraying the tree from three sides and using more material than would have been required had it been possible to spray both sides with the wind. Wherever the wind is at all against the operator a spray gun is much better than a rod and nozzles.

SPRAY CALENDARS.

Two spray calendars, one for apples and the other for pears and tender fruits, have been prepared by the entomologists and plant pathologists of the Province and Dominion acting in co-operation. These calendars are revised annually and thus are always kept up-to-date. They tell the time to make each application, the mixture to use, the right strength of each and the number of applications necessary. No grower can afford to do without these calendars. Be sure to get the new ones each year.

DUSTING VERSUS SPRAYING.

Applying spray materials by means of a power duster is a very rapid and handy method, but unfortunately most persons fail to obtain as good control by it as by spraying. Nevertheless where there is a large orchard, a duster is very convenient and enables the grower in an emergency to treat his whole orchard before it is too late. If only one outfit is to be used, we advise the sprayer as much the more reliable, especially as oil sprays are sometimes necessary and these of course can only be applied by a sprayer.

Dusting fruit trees for insects and diseases. (Original.)

APPLE SCAB, (*Venturia inaequalis* (Cke) Wint).

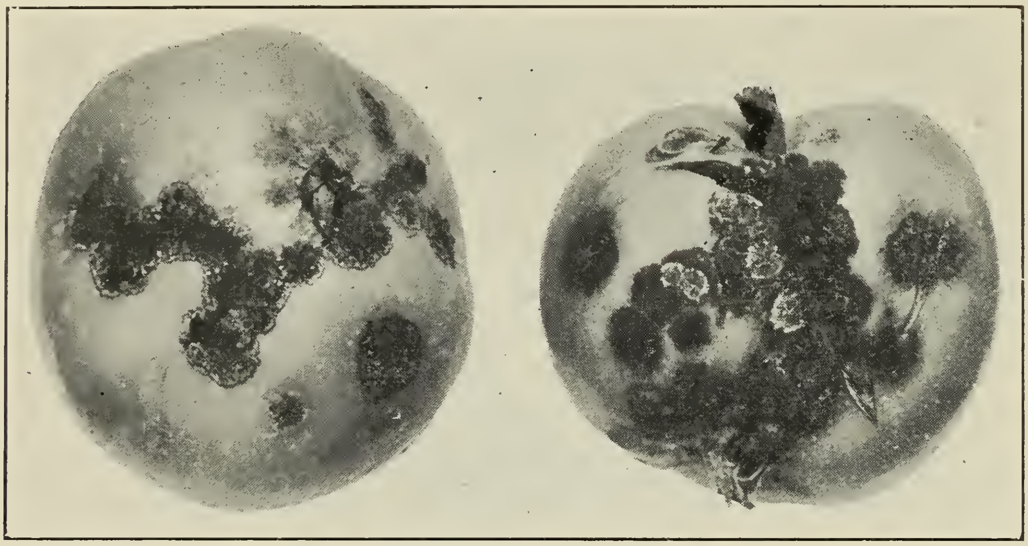
This is the most common and most serious disease of apples in Ontario. It occurs wherever apples are grown and the scab spots on the fruit and leaves are familiar to almost every fruit grower. It is the chief disease that the grower has in mind when he is doing his spraying. In wet seasons scab causes a loss of many thousands of dollars to the fruit growers of the Province. This is to a large extent a needless loss, for apple scab can be prevented, no matter how wet the season may be, by timely, thorough and intelligent spraying. Such spraying, however, can be done only when the fruit grower understands the nature of the disease and how it is spread, and knows the climatic conditions which favour the spread and development of the fungus which causes it. Such knowledge is invaluable in the control of apple scab. It makes clear the necessity for timely and thorough spraying to insure protection of fruit and foliage from scab infection during the times in the spring and summer that it is most likely to occur.

Symptoms—Apple Scab affects the blossoms, fruit, leaves and rarely the twigs. It is most conspicuous on and does most damage to the fruit and leaves. Scab may appear on the fruit during any stage of its development provided climatic conditions are such as to render possible the spread and growth of the fungus which causes it. Young fruits on which scab spots develop are often stunted and deformed. Mature fruit is rendered unsightly and unsaleable by the conspicuous black and brown scab spots often bordered with a greyish rim. In severe scab there is sometimes a cracking of the fruit, such as is often seen when Pear Scab destroys Flemish Beauty pears. Not only does the scab render the fruit unsightly but it also makes it very liable to shrivel or rot in storage. If scabby apples are packed during moist, warm weather, or kept in a moist condition, a pinkish white mould is very likely to develop around the edges of the spots. This soon causes a rotting which markedly injures the fruit and makes it unpalatable. This is known as Pink Rot. Other rots caused by Blue Moulds (Penicillium) and other fungi, also develop around scab spots on apples in storage. Such fruit of course is hard to market and can be sold only at very much reduced prices. In some seasons apples when packed show little or no signs of scab but when they are examined two or three weeks later small scab spots are found to have developed on them. This is due to the fact that spores of the scab fungus were on the apples when they were packed and there was sufficient moisture in the barrels for these spores to germinate and infect the packed apples.

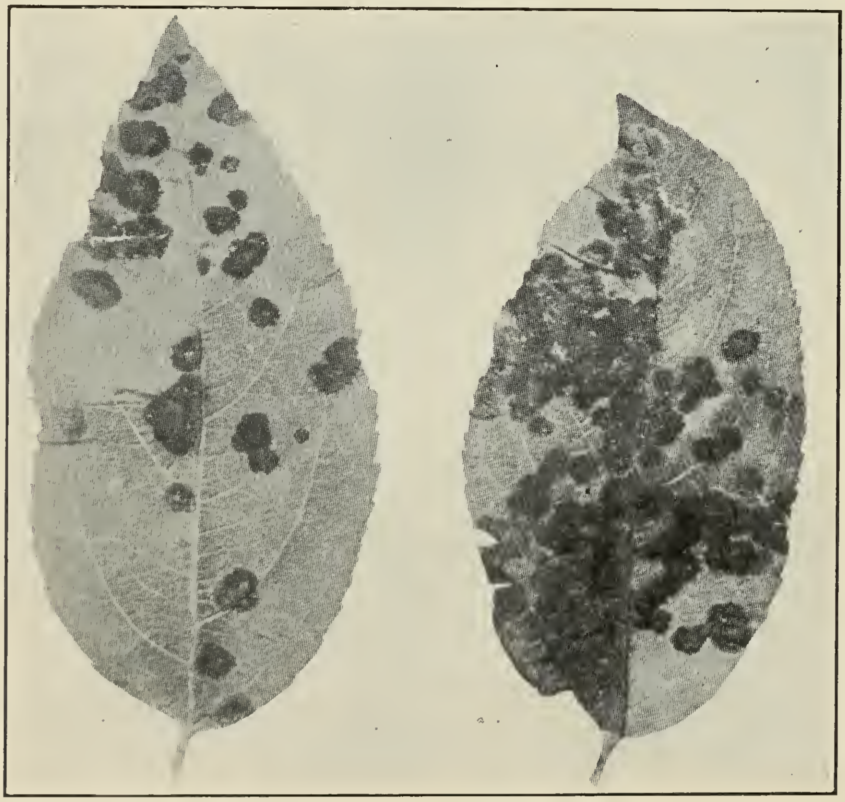
On the blossoms scab usually appears first on the tips of the sepals. Sometimes it affects the stems of the blossoms, causing them to drop, thus reducing very markedly the set of the fruit. Frequently the scab fungus infects the base of the calyx of the blossom, and, as this will become the fleshy part of the apple, such infections result in the young fruits being scabby and often deformed.

On the leaves the scab first appears as small, somewhat circular olive-brown spots which are seen first on the lower surface and later on both surfaces. Under weather conditions favourable to the fungus these increase in size, run into each other and become brown or black so that a considerable portion of the leaf is destroyed. In severe attacks the leaves become crinkled and to some extent curled. Sometimes they fall but most frequently they remain on the tree. The leaves are the food factories of the tree. The food manufactured by them is used for the growth of the fruit, stems and root, and for the formation of fruit buds next year. Hence severe injury to the leaves by scab impairs the vitality of the tree and prevents the normal development of fruit buds, and thus may reduce the crop.

Varieties of apples differ very much in regard to their freedom from scab. It is a great help in controlling scab to know something regarding the susceptibility of the different varieties, as the scab is very much harder to control on varieties which are very susceptible to it than on those which are not. Common varieties of apples which are (a) very subject to scab—Snow, McIntosh, Gravenstein, Early Harvest, Stark, Baxter, and St. Lawrence; (b) moderately subject to scab—Spy, Rhode



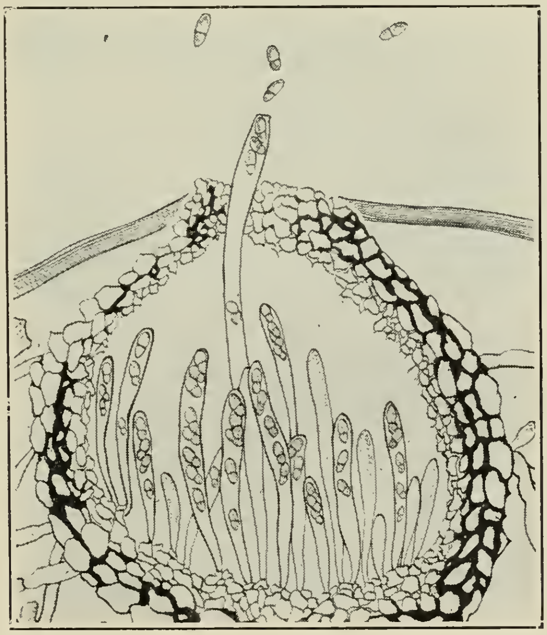
Apple Scab on fruit. (Original.)



Apple Scab on leaves. (Original.)

Island Greening, King, Baldwin and Ben Davis; (c) slightly subject to scab—Duchess, Blenheim, Yellow, Transparent, Tolman and Golden Russet.

Life History—The fungus which causes scab passes the winter chiefly in the fallen leaves beneath the trees. If these are examined in the early spring small black points will be seen projecting from the skin of the leaf on one or both sides. They vary in size from a mere speck to a pin head. Each is a fruiting body (perithecium) of the fungus and contains numerous long, sac-like structures (asci), (see illustration), each of which in turn contains eight two-celled spores (ascospores). When mature each fruiting body (perithecium) opens by means of a minute pore through which the spores are shot out from the sacs by a peculiar popgun-like arrangement. Moisture is necessary for the discharge of these spores, which takes place chiefly during the spring rains from the time the blossom buds are bursting until the petals are falling. Some of these spores however, may be discharged much later in the season than this. These spores infect the unfolding leaves and blossoms, and give rise to the first scab spots of the season. Moisture is essential for the discharge of these spores and for their germination and development. When there is plenty of moisture these spores germinate and send out a tiny thread-like structure (germ tube) which penetrates beneath the outer layer of the skin (cuticle) of the leaf or blossom. It has been shown that the leaves must be continuously wet for several hours before this takes place. It is, therefore, only when we have a day or two of rain or heavy fog that the fungus spores are scattered through the orchard and infection takes place.



Section of Fruiting Body (Perithecium) of the Apple Scab fungus, showing the discharge of the spring spores (ascospores). (After Wallace.)

About ten to eighteen days after the spores from the fallen leaves have infected the leaves or young fruit, the first scab spots of the season are observed. These, if examined with a microscope, are found to be composed chiefly of spores and fungus threads. These spores are produced on little stalks right on the surface of the scab spots, the fungus having developed under and pushed off the outer layer (cuticle) of the fruit or leaf. If the weather is dry and warm they can do no harm as moisture is necessary before they can be scattered freely and germinate, but if a period of wet weather comes the spores on the scab spots are scattered by rain and wind-borne rain, and infect the leaves or fruits and in ten days or two weeks another crop of scab spots is developed. If the weather is wet the spores from these may in turn give rise to more scab spots, so that there may be several successive generations of these spores during a wet season. In seasons of average weather conditions for Ontario, the period when most infection occurs is from the time when the blossom clusters are pushed up in the buds until about twe weeks after the petals fall. Infection, however, may occur earlier than this—when the fruit buds are bursting. In some seasons serious infection may also occur later, about the end of June. May and June are nearly always the months in which there is the greatest danger of scab becoming serious. During July and most of August the scab fungus can rarely develop because at this time of the year there is not sufficient continuous moisture as prolonged wet periods seldom occur, and the days are long and the nights comparatively short and warm, so that the leaves and fruits are quickly dried even after heavy showers. In August and September, however, prolonged cool wet weather may occur and at this time there is danger of late infection.

Prevention—Apple Scab can be prevented by timely and thorough spraying in combination with the proper pruning of the trees. It is all important that spraying should be done at the right times. The spray mixture must be on the leaves and fruit before the spores reach them. We have already learned that the spores are scattered and develop only during wet weather. The times of the year, therefore, when we get our wet weather, are the times we have to spray if we are going to prevent scab. One spraying with either lime sulphur or Bordeaux mixture is not sufficient, as the rain gradually washes the spray off and as the leaves and fruit, by growing larger, develop more surface to cover. In order to be sure of preventing the disease we must spray from three to six times during the season, the number of sprayings depending upon whether the weather is wet or dry. Four applications are given usually every year, namely: the early leaf and pre-pink spray, the pink spray, the calyx spray, and the small apple spray.

Early Leaf and Pre-Pink Spray—This spray should be given between the time when the fruit buds on most varieties have clearly burst and the time when the blossom bud clusters have begun to push up in the buds. It is usually advisable to commence spraying when the fruit buds on most varieties have clearly burst. (Fig. 1.) Try to cover two-thirds of

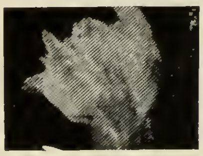


Fig. 1.

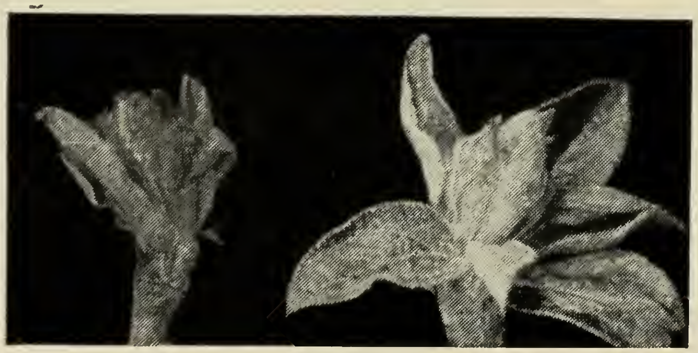


Fig. 2—Early-Leaf and Pre-Pink Spray.

each tree from the one side at this stage. Spray the other side as soon as the blossom bud clusters have begun to push up in the bud on most varieties. (Fig. 2.) Try again to cover two-thirds of each tree. If the weather is wet or rain threatening at either of the above stages spray both sides of the tree. For this spray use either Bordeaux 3-6-40 or lime sulphur, 1 gallon to 40 gallons of water (sp. gr. 1.007-1.008). If cigar-case bearer or bud moth is abundant add 1½ pounds of arsenate of lead to the mixture.

Pink Spray—This should be given when most of the blossoms are showing pink. At this time use lime sulphur, 1 gallon to 40 gallons of water (sp. gr. 1.007-1.008) and add 3 pounds of hydrated lime and either 1½ pounds of arsenate of lead or 1 pound of calcium arsenate to every 40 gallons of the spray. The ideal time to apply the pink spray is just after the blossom buds have separated (Fig. 3), but in a cool, wet season it is not safe to wait until this stage is reached. In such a season spray one side of the tree after the blossoms are showing pink but before they separate and spray the other side immediately after they separate. If the blossoms open before this spraying is completed, omit the poison and finish the application.

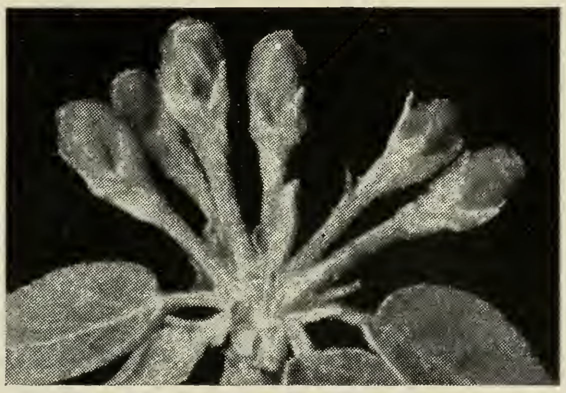


Fig. 3—Pink Spray.

Calyx Spray—This should be given immediately after the blossoms have all or nearly fallen (Fig. 4.) For this application use lime sulphur, 1 gallon to 40 gallons of water (sp. gr. 1.007-1.008), and 1½ pounds of arsenate of lead and 3 pounds of hydrated lime. Always put the lime in the tank before adding the poison. This is generally a very important spray

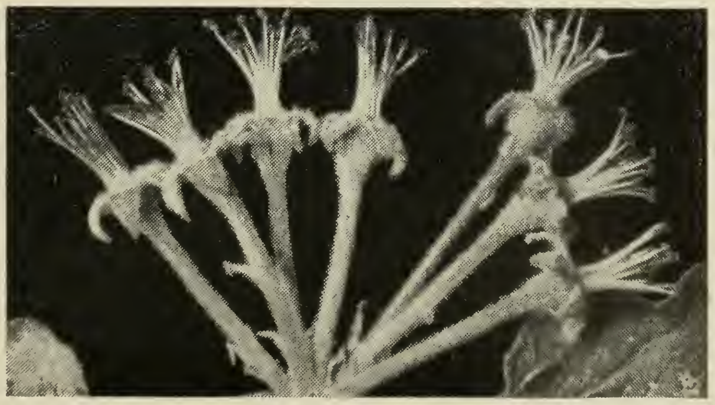


Fig. 4—Calyx Spray.

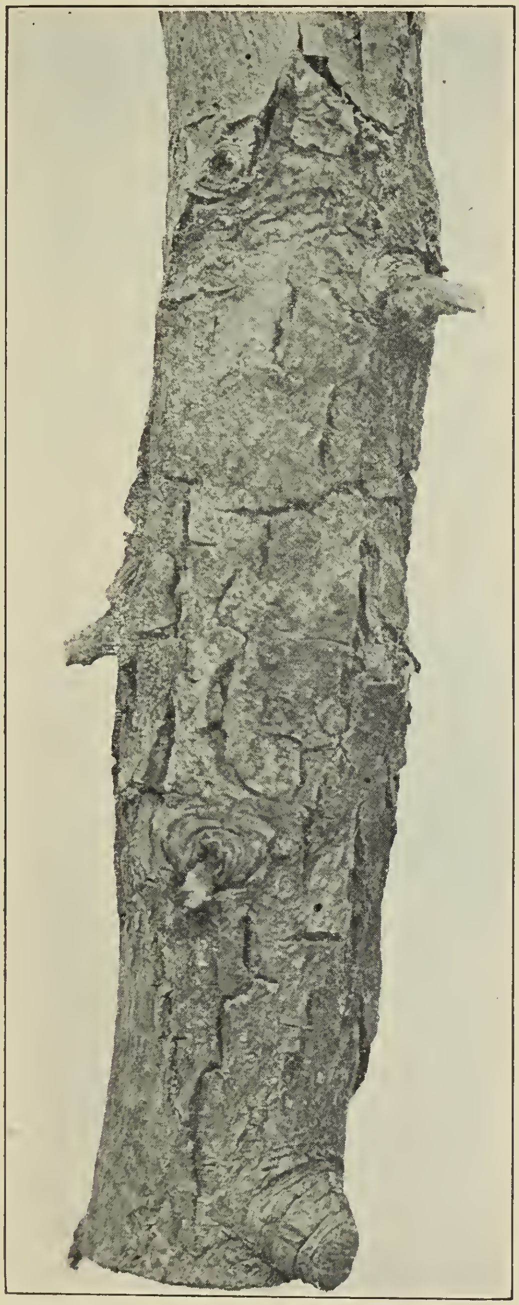
in the control of apple scab and always the most important application in the control of codling moth. It must be promptly applied as a delay of a day or two may make all the difference between success and failure. In order to control the codling moth the calyx cups of the little apples must be filled with poison. This means that the spraying must be very thoroughly done. If the trees are large it is advisable to have a tower or support on the tank in order to do thorough work, as it is necessary to reach all parts of the tree and to have the spray mixture carried through the tree from one side to the other as a fine mist, if it is going to reach all the small fruits.

Small Apple Spray—This should be given about twelve days after the calyx spray to all trees with fruit on them. At this time use lime sulphur, 1 gallon to 50 gallons of water (sp. gr. 1.006). Apply in the form of a fine mist for fear of injuring the foliage. This spraying can best be done from a tower or the top of the spray tank. No poison need be added at this time, if a special spray about two weeks later is to be given for sideworms or apple maggots. Otherwise add 1 pound of arsenate of lead to every 40 gallons after putting in 3 pounds of hydrated lime.

Late Applications for Scab in Wet Weather—The best insurance against late attacks of scab is thoroughness in the first four sprays. If, however, owing to very moist cool weather in early August, a late attack is feared, spray with lime sulphur alone, 1 gallon to 50 gallons of water (sp. gr. 1.006), not later than August 15th. Spray from tower or top of the tank and apply as a fine mist. Do not spray on a hot calm day for fear of sunscalding the fruit.

It is necessary to vary somewhat from year to year with weather conditions the exact time of these various applications, the object being so to time our sprayings that the new growth will always be covered with the spray mixture during prolonged wet weather. To accomplish this it is necessary to study the weather conditions and forecasts each season so that we can make our application just at the right time to do most good.

BLACK ROT CANKER, BLACK ROT AND LEAF SPOT, (*Physolospora cydoniae*, Arnaud).



Black Rot Canker on branch. (Original.)

This disease is found in most parts of the Province, and is worst generally in poorly cared for and neglected orchards. In the apple-growing districts east of Toronto it has caused serious injury to apple trees and much alarm to the growers. In that part of the Province, however, it is not by any means confined to neglected orchards. Observations and experiments show that the fungus causing Black Rot Canker is unable to penetrate healthy bark, and can gain entrance and produce cankers only through wounds owing to various causes, such as winter injury, sunscald, carelessness in cultivation, pruning and picking of the fruit. Varieties of apples which are most susceptible to Black Rot Cankers are those which are too tender for the district and so suffer severely from winter injury and sunscald.

The fungus which causes Black Rot Canker is not confined to the apple. It is recorded as affecting pear, quince and other trees, but the writers have not observed it at least to any appreciable extent in Ontario on any host but the apple.

Symptoms—This disease affects the trunk, branches, leaves, fruit and sometimes the twigs. It causes most damage by the cankers produced on the trunk and larger limbs. On the leaves circular spots from one-eighth to one-quarter of an inch in diameter are produced. These are brown in the centre, with a distinct purplish margin. Towards the centre of these spots the minute black fruiting bodies (pycnidia) of the fungus can often be seen by a careful observer. The leaves are seldom severely injured by these spots, but frequently they are plentiful enough in unsprayed orchards to attract the attention of the grower.

On the fruit a small brown spot first appears. This gradually increases in size until the whole fruit becomes rotten, brown, and later black. The surface becomes covered with minute black fruiting bodies (pycnidia), which helps to give to the rotted fruit a black appearance. For some time the affected fruits remain firm and retain their normal form, but finally shrivel. These black, shrivelled fruits are frequently seen hanging on the trees or lying on the ground beneath. In Ontario, the rotten fruit in the orchard is not abundant and is seldom noticed by the grower except on Alexanders. In storage also, so far as our observations go, the Black Rot on the fruit attracts but little attention.

On the trunk and larger limbs discoloured areas appear on the bark. These may increase in size, forming large cankers, which with age become cracked, rough and black. These cankers may be only a few inches long, or they may be a yard or more in length. They are usually found on the southwest side of the trunk and on the upper side of the larger limbs, these being the parts of the tree that are most likely to suffer from sunscald and winter injury. In many cases the cankers gradually enlarge, extending completely around the trunk or branch, and penetrating through the bark to the wood, thus girdling the part attacked. The cankers in this way frequently destroy the larger limbs, and, when they occur on the trunks, which they very often do, may cause the death of the whole tree. Sometimes the cankers remain small. Frequently even the larger ones do not penetrate deeply, and cause merely a superficial roughening of the bark, which in time may disappear. Embedded in the bark of the cankers small, black, pimple-like structures may be seen with the naked eye. These are the fruiting bodies (pycnidia) of the fungus.

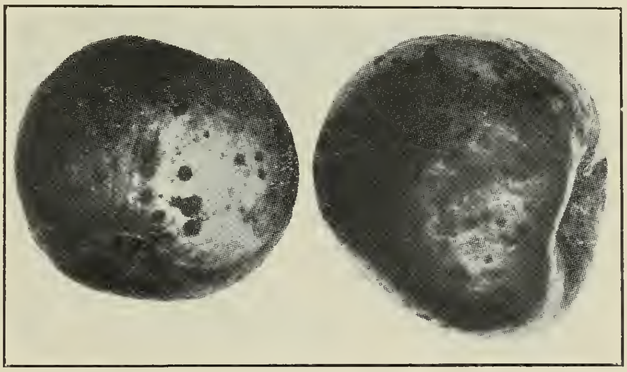
Life History—The fungus causing this disease is carried over the winter chiefly in the form of dormant fungus threads (mycelium) in the cankers and immature spore cases (pycnidia) which are seen in abundance as little black specks in the skin of the rotted apples, the bark of the cankers and to a less extent in the spots on the leaves. In these spore cases numerous spores (pycnospores) develop which mature and are discharged during the spring and early summer. A second form of spores (ascospores) are sometimes developed in fruiting bodies (perithecia) embedded in the bark of the cankers. It is also probable that some of the spores discharged from the spore cases (pycnidia) in the summer, winter over in the crevices of the bark. As has been stated before, observations and experiments have shown that infection can only take place through wounds in the bark, the spores being unable to infect sound and healthy tissue. Winter injury, sunscald, carelessness in cultivation, pruning and picking of the fruit, or other causes make wounds through which the fungus gains entrance into the bark and finally spreads and causes cankers. Varieties which suffer from winter injury and sunscald are very subject to Black Rot Canker because it is chiefly through such wounds that the fungus gets a start in the healthy bark.

Treatment—Plant only those varieties which are known to be hardy in the district where they are to be grown. Keep the trees thrifty by proper pruning and cultivation. In districts subject to extreme cold during the winter months, do not cultivate later than the middle of June, then sow a cover crop. Such treatment will check the growth of the trees and cause the wood to harden for winter. Cut out all cankers on the trunk and larger limbs, except those that are merely superficial. Use a drawknife for this purpose and cut back to healthy bark, taking care to leave the edges of the wound smooth, even and perpendicular. Wash the wounds thoroughly with concentrated lime-sulphur or with bluestone, one pound to ten gallons of water, and paint over with coal tar or white lead mixed with linseed oil without turpentine. White lead checks and cracks, and if it is used the wounds will have to be painted over two or three times. Coal tar does not check or crack, but slightly discolours the bark around the edges of the wounds. The writers, however, have never noticed any serious injury to the bark from the use of coal tar on apple trees. Badly cankered trees, which would be dead in a year or two if neglected, can in many cases be saved by cutting and treating the cankers as described above. In pruning it is often advisable to cut out and burn large limbs which are badly cankered, if this can be done without causing too much injury to the tree. Sometimes, when it is necessary to remove a badly-cankered main limb, a sucker nearby can be left to grow and take its place. Proper spraying is also of importance in controlling this disease.

Spray the trees as recommended for the prevention of Apple Scab. Give special attention to the first application and take care to see that the trunk and main limbs are thoroughly covered with the spray mixture at this time.

SOOTY BLOTCH [*Gloeodes pomigena,* (Schw) Colby].

This disease sometimes disfigures apples and by so doing much reduces their market value. Spy and Greening appear to be particularly susceptible to it. It does not usually appear until late summer or early fall, and only becomes prevalent enough to cause serious disfigurement of the fruit when the weather is exceptionally wet at this time of the year.



Sooty Blotch. (Original.)

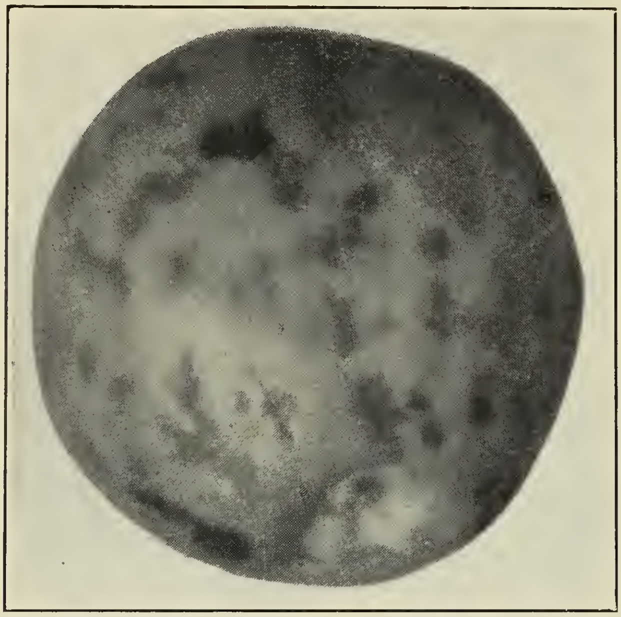
Symptoms—The disease is easily recognized by the characteristic irregular sooty blotches which the fungus causes upon the fruit. These may be few and scattered or numerous and often coalescing so as to give a sooty appearance to a considerable area of the surface of the apple. Affected fruits are disfigured and rendered unattractive but the flesh is not injured as the fungus does not penetrate below the skin.

Prevention—Prune the trees to let in plenty of light and air as Sooty Blotch is always worse where the dense foliage keeps the fruit damp for a long time after showers and heavy dew. Spray the trees as recommended for the prevention of Apple Scab. In a very wet fall the late or August spray is important in the control of this disease. (See directions for spraying to prevent Scab).

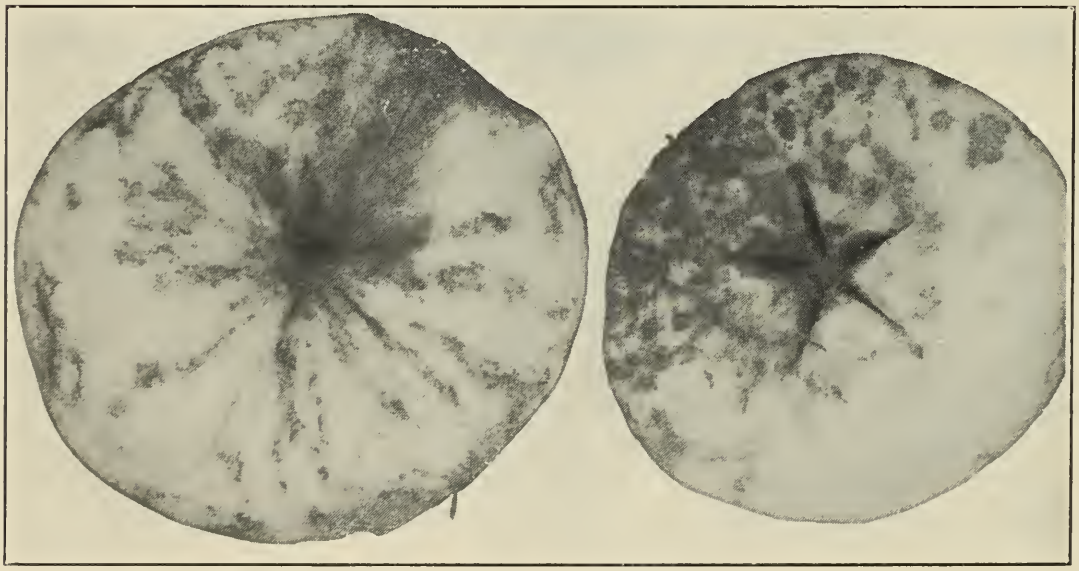
STIPPEN, BALDWIN SPOT OR BITTER PIT.

This disease is frequently seen in Ontario. The Baldwin and Spy are particularly subject to it, but it is by no means confined to these varieties.

Symptoms—Small, sunken, dark spots, from one-sixth to one-quarter of an inch in diameter are seen on the surface of the fruit. The skin of the spot is usually unbroken. The flesh beneath is dead and brown, and frequently similar brown spots and streaks are scattered through the interior of the fruit. Very often apples may be badly affected in this way without showing the characteristic pits on the surface. This form of the disease may be referred to an internal stippen. So far as one can judge, it occurs early in the growing season and is mistaken frequently for the work of the Apple Maggot, which it resembles to some extent. Occasionally fruits may be deformed, due to the extreme development of internal stippen. Frequently, apples apparently sound when picked, develop the external form of the disease in storage.



Stippen or Bitter Pit. (After McAlpine.)



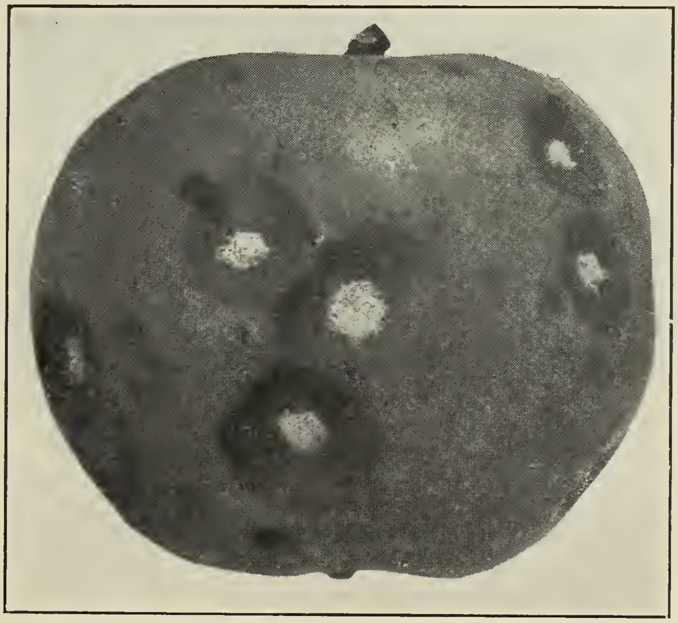
Internal Stippen. (Original.)

This disease is not caused by any fungus, bacterium or insect. Authorities agree that Bitter Pit is chiefly due to a disturbed water relation. The conditions tending to the production of Stippen or Bitter Pit appear to be, first: extreme variation in the water supply to the trees during the growing season which tend to check and stimulate alternately the growth of the fruit; second, soils of poor physical or mechanical condition, especially those lacking sufficient humus and having a poor water-holding capacity; third, trees which produce a light crop of over-size fruits; fourth, heavy pruning or a system of pruning which causes the fruit to be produced on the main limbs rather than on well-distributed laterals.

Prevention—So far as is known very little can be done to prevent this disease beyond adopting those horticultural practices which tend to an even normal development of the fruit throughout the season. Such practices include, first, the increasing of the water-holding capacity of the soil by the liberal use of manure or by the use of cover crops suitable to the locality; second, cultivation or mulching to ensure moisture and equalize the available supply throughout the growing season; third, proper pruning so that the crop is evenly distributed over the tree and balance maintained between the root system and the top; fourth, underdraining of the orchard, when there is any indication that it would help the trees.

PINK ROT (*Cephalothecium roseum* Cda.)

Pink Rot is chiefly a storage trouble, suceeding Apple Scab. It is found on scabby apples which have been packed during moist weather or stored in a damp place. The fungus which causes this rot cannot penetrate the sound skin of the apple, and can gain entrance to the flesh only through scab spots or other wounds. Greening and Snow are particularly subject to Pink Rot.



Pink Rot following Apple Scab. (Original.)

Symptoms—A whitish mould sometimes with a distinct pinkish tinge develops around or upon the scab spots. This is followed by a brown rotting around the spots, which markedly disfigures the fruit and renders it unpalatable.

Prevention—Spray thoroughly to prevent Apple Scab. Pink Rot never causes serious injury except to scabby apples. In packing, discard any fruits showing signs of white mould. Store the fruit in a cool dry place as soon after picking as possible. If possible pick and pack when the weather is cool and dry.

PEAR BLIGHT, (*Bacillus amylovorus,* Burrill).

This destructive disease is usually known by the above name, but fruit growers speak of it also as Blight, Fire Blight, Twig Blight, Blossom Blight, and, when it infests the trunk, as Body Blight.

It attacks not only pears, but also apples, crab apples, quince, mountain ash, hawthorn and juneberry. The last three are rarely much affected, but pears, apples, crabs and quince suffer severely in seasons favourable for the development of the organism. So destructive is the Blight to pears that many good orchards have been almost totally destroyed by it; in fact so great has been the loss that in many districts fruit growers have given up pear growing in the belief that they cannot successfully cope with the disease. Apples do not suffer so severely as pears, yet some varieties, even of large, bearing trees, are much injured, and young, rapidly growing trees of very susceptible varieties are not infrequently killed. All varieties of quince are much damaged by the killing of branches and twigs, though the trees themselves are not often killed.

Young pear orchard in early spring, showing blighted branches. The presence of the leaves indicates where the disease is. (Original.)

The disease is found in nurseries as well as in orchards.

There is a great difference in the relative susceptibility of the various varieties both of apples and pears to attack. It is generally agreed that Clapp's Favorite is the most susceptible pear. Flemish Beauty and Bartlett are also quite susceptible, whereas Kieffer is least affected and Seckel is rarely severely attacked. Of apples, Alexander is usually the most susceptible and after it King, Tolman, Gravenstein and Rhode Island Greening. Among those least susceptible to infection are Spy, Duchess, and Ben Davis. No variety, however, either of apple or pear, is entirely exempt, especially from infection through the blossoms, even Kieffer pears often having many blossoms blighted.

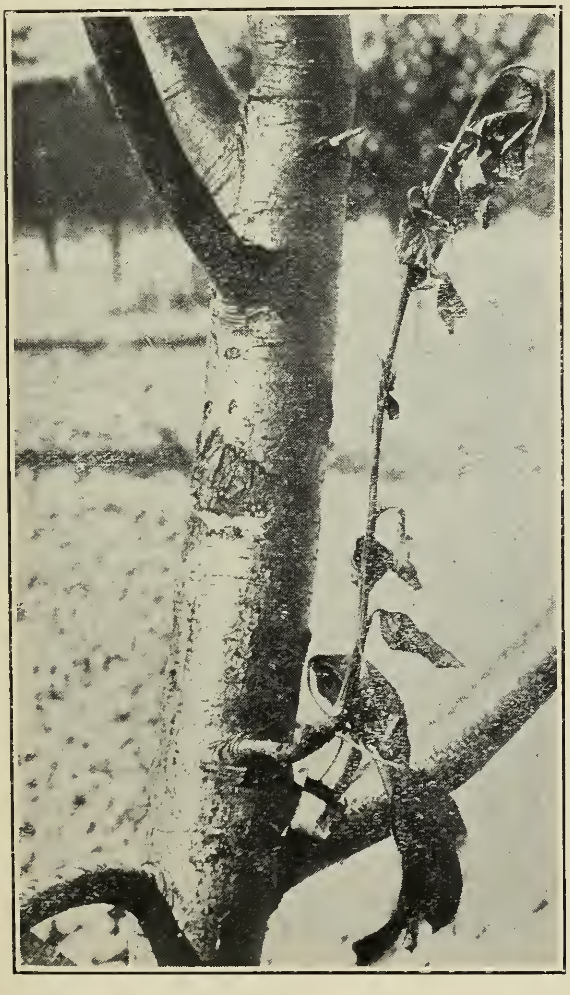
Symptoms—The disease manifests itself in several ways.

(1) In early June soon after the blossoms have fallen we often see the fruit clusters and the leaves immediately surrounding them wilting and dying, and in a few days turning brown on apples and nearly black on pears. There may be hundreds of such diseased twigs or fruit spurs

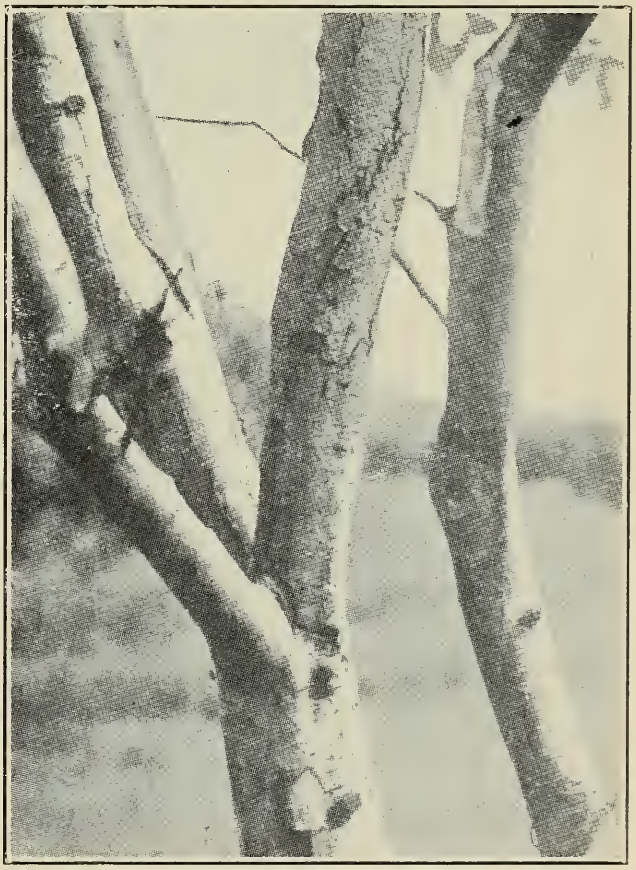
on a single tree. This stage of the disease is usually called Blossom or Twig Blight and is caused by the organism having been introduced into the blossoms by insects or by driving rains and becoming established there.

(2) Throughout the remainder of the season it is common to find watersprouts, suckers and branches of various sizes dying. The leaves on these usually do not drop but remain attached for months and sometimes even through the winter. Most of these later infections can be traced back directly or indirectly to the Blossom Blight mentioned above.

(3) Not infrequently the trunks and main branches become infected either as the result of the disease working down from smaller branches or from its getting into a watersprout and running down this into the trunk or branch, or from direct inoculations by some bark or wood-infesting insect that had just previously fed upon a diseased part of some tree. All these cases are often spoken of as Body Blight. Roots of trees may also become inoculated through infected suckers, the disease running down these into them. On pear trees, infections of the trunk or main branches or roots are likely to mean the death of the trees unless the affected areas are promptly cut out and disinfected. But on apples, such infections usually live for only a few weeks and then die, though they often leave a



Blighted twigs on pear trunk. The disease runs down such twigs and enters the trunks or branches. (Original.)



Main limbs of a Flemish Beauty pear tree, O.A.C. orchard, in which the blight is rapidly spreading. The limb to the right is practically dead. Notice the cracking and blistering of the bark, especially on the middle limb. All the disease above the crotch developed this season from the cankered area below the crotch. It spread throughout the bark very rapidly during June, July and August. Photo taken in September. (After Jones.)

dead area or canker varying in diameter from one to several inches. Very susceptible and succulent young apple trees are, however, sometimes killed outright by Body Blight.

(4) Occasionally the fruit becomes infected and is destroyed; but the total loss of fruit from this cause alone is small.

Cause of Blight—The disease is caused by a very tiny bacterial organism, known as Bacillus amylovorus. This is so small that at least 10,000 individuals could find room on the head of a pin. These germs work chiefly in the tender tissues of the bark and have marvellous powers of multiplying; millions may be produced from a single one in a day. They feed on food substances present in the living bark and soon kill the part attacked. Warm, moist weather, which causes rapid growth and a succulent condition of the bark favours greatly their development; whereas drought by checking the growth and thus lessening the succulence of the trees and especially of the bark soon checks the progress of the disease and in many cases even destroys the organism itself. There seems, in fact, no reason to doubt that the variation in the amount and virulence of the disease over large areas one year compared with another must be attributed chiefly to the difference in the sort of weather that prevailed, though no one has yet been able to analyze fully all the effects of weather.

Means of Distribution—During the winter the Blight organism lives in the healthy bark that bounds the dead areas. In spring when the sap begins to move through the trees the germs begin to multiply and by the time the blossoms are opening, sometimes clog the tissues of the bark to such an extent that a sticky fluid containing countless germs breaks through to the surface. If this exudate happens to be high up on the tree driving rains will dilute it and carry the germs to blossoms below either on the same tree or on neighboring trees. Then bees or other insects visit these inoculated blossoms and spread the disease to other blossoms and inoculate these, and from them in turn thousands of blossoms here and there throughout the orchard may become diseased.

Another method of spread is through ants, which often feed upon the sticky exudate wherever it may be and thus get their mouth parts and feet covered with germs. These same ants a little later visit the blossoms to feed upon the nectar and thus inoculate them. Other insects as well as ants may act in this way. Then the bees, wasps and other bloom-frequenting insects visiting these same blossoms carry the germs to other trees.

After the blossoms have fallen and the disease has become well started on the twigs and fruit spurs, sucking or biting insects, such as aphids or bark beetles, which may happen to feed upon a diseased leaf or twig, can carry the germs on their mouth parts to new twigs and inoculate them. The chief time of distribution in an average year is during the blooming season, but some goes on all through the growing season.

Methods of Control—*The first step* in control is to put the right man in charge of the work; for only a careful, observant and interested person is likely to make a success of it.

The second step—the one on which the success of the work will chiefly depend,—is to cut out and burn during the winter or early spring and never later than April 1st all diseased pear twigs and branches and to remove all the bark over any local diseased area on the trunk or main branches. Trees of course, in which the crotch or trunk is so badly diseased that there is no hope of saving them should be totally removed and burned. The object of this destruction of all diseased trees and parts of trees at this time of the year is to remove as far as possible all sources of later infection, especially infection at blossom time. Any person who fails to do this early cutting and burning is going about the work in a wrong way and need not expect to control the Blight in a year favourable for its development.

An inexperienced operator will at first have considerable difficulty in detecting some of the diseased areas on the trees, especially where these are on the trunk or main branches and the part above still looks healthy. Hence he should first go through the orchard and remove all the branches whether large or small that he can plainly see have been killed by the disease and in so doing observe the colour of the bark on these and how it differs from healthy bark. He should also note that on some of the larger branches diseased bark will not only be darker but also be swollen, more or less spongy and sometimes ruptured in many places. In this way he will soon get his eyes so well trained that he can readily pick out diseased areas anywhere, though certain shrunken places on the bark may at times give him trouble. These places are often in no way connected with Blight and are characteristic of pear trees. By cutting them through with a knife and observing that the wood beneath the inner bark is healthy he will be able to recognize that they are not diseased; for if Blight were the cause the bark and also the wood immediately beneath would either be dead or there would be reddish brown streaks present.

When the blighted branches are being removed they should always be cut a few inches below the limit of the dead area, because the disease germs, as stated above, winter over not in the dead bark but in the living bark adjoining the dead. In the same way when cutting out any dead area on the trunk or main branches, it is necessary to remove the living bark all around it as far back as there is any sign of the reddish-brown streaks; for such streaks are an indication of the presence of the disease.

The most convenient tools the writer has yet found for cutting out dead or diseased areas in the bark are a sharp drawknife and a stout jack-knife. A saw and a long-handled pair of pruners are good tools for removing branches and twigs. It is convenient of course, to carry along also a pair of small hand-pruners.

Very few men, even though experienced, will be able to see and remove all blighted parts by merely going over an orchard once. The writer found it was always wise to go over every tree twice and in some cases three times. This is specially true when the operator is inexperienced.

No disinfectant is necessary in this early cutting out of diseased parts, provided the work is finished before the sap begins to move through the trees in spring.

The third step—in control of Blight is to watch for the first indications of Blossom Blight and remove the affected twigs as soon as they show infection. Blossom Blight begins to appear about a week or a little later after the blossoms have fallen. The first indication of it is the wilting of the leaves around the little fruit clusters.

In order to prevent the disease from running down the infected twigs or fruit spurs into the main branches and thus making it much more difficult to treat, it is necessary to remove the twigs as quickly as they show by their wilting that they are infected. *Not a day should be lost in doing this.* The easiest and best method is to drive a truck or dray close alongside each tree and from it or from the ground or a step-ladder, break off every diseased twig or fruit spur. It is much safer and quicker to break them off by hand than to cut them off, because in breaking there is no danger of spreading the disease and no need of using a disinfectant. All the twigs will not show the disease the same day so it will be necessary to go over the trees about three or four times at intervals of a day or two to make a thorough job. So far as practicable the broken off twigs should be thrown on the truck or wagon and hauled off and burned. If this removal of the Blossom or Twig Blight is done promptly and thoroughly there will be very little further difficulty the rest of the season, though it will be necessary about once a month to look over the trees and remove any branches that have later become infected. In cutting these out it is very important to make the cut at least six inches or if possible a foot or more below the lowest sign of the disease on the bark, because the disease may have advanced several inches in the bark without showing any external evidence. If the branches are short examine the bark at the base and remove it as far as it shows any indications of disease being present.

Disinfectant and Methods of Using It—Corrosive sublimate, 1 part to 500 parts of water, was for a long time the disinfectant used, but recently is has been found that a better disinfectant is 1 gram corrosive sublimate and 1 gram of mercuric cyanide to 500 cc. of water. If there are many trees in the pear orchard at least half a gallon of this should be made up at a time by a druggist and kept in an earthen or glass vessel as it injures metals. The simplest method of using it is to carry along a bottle-full with a piece of sponge in the top instead of cork. Turn the bottle upside down until the sponge is wet then after each cut rub the wet sponge over the surface of the cutting tool and also of the cut on the tree.

Caution—This mixture is a deadly poison, and should be so labelled.

All cuts made in the growing season must be disinfected otherwise the saw or other cutting tool will soon become infested and will thus spread the disease.

A fourth helpful step in control is to remember that the disease often gets into the trunk and main branches by running down watersprouts and into the roots through suckers; hence it is a good plan to go through the orchard occasionally and rub off with the thumb all watersprouts while still small, and cut off below the surface of the soil all suckers.

A fifth measure—is not to encourage great growth and succulency of trees, because this favours the disease. Hence after the trees have begun to bear or to blossom do very little pruning and either grow them in a sod mulch or else lessen the amount of cultivation and of fertilizers.

It is also well in setting out new orchards not to plant Clapp's Favourite or the Alexander apple because of their great susceptibility to Blight and the menace they therefore are to the rest of the orchard. It is also wise as a rule not to plant apples and pears in the same orchard.

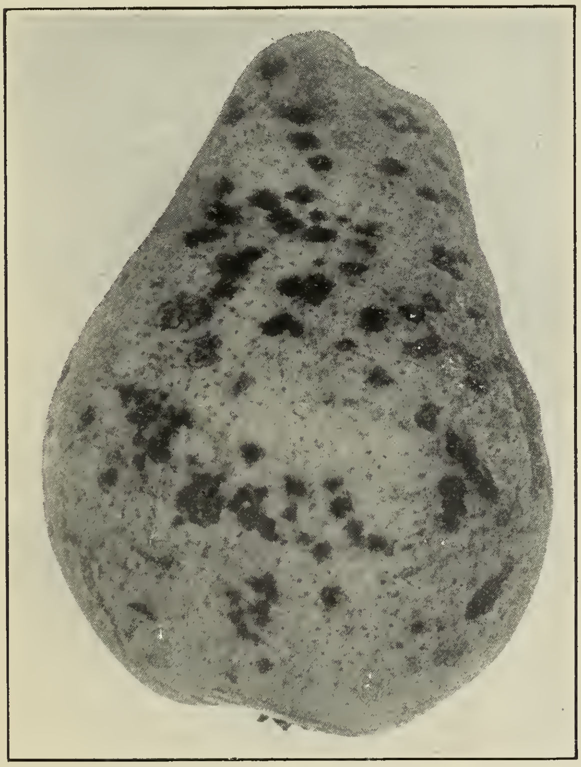
In conclusion it may be said that quince and young apple trees may be treated for Blight in the same way as pears but that on large apple trees the cutting out of Blossom Blight is impracticable and not so important, because usually the disease dies out before entering the main branches or else soon after it enters. Where old apple trees are heavily blighted cease cultivation and put them into a sod mulch and try to remove all diseased branches as on pears in winter or early spring.

Note—For a much fuller account of this disease see bulletin No. 342, by Prof. D. H. Jones.

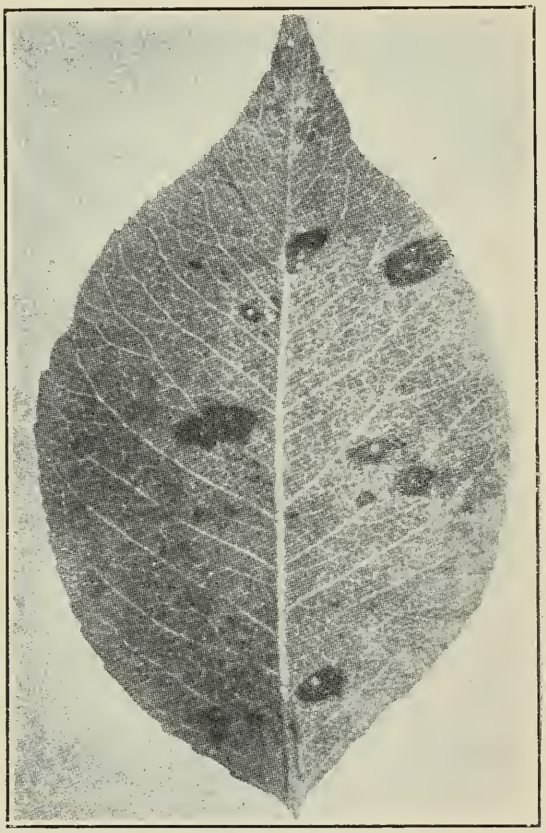
PEAR SCAB (*Venturia pyrina,* Aderh.)

Pear Scab is similar in nearly every respect to Apple Scab. In Ontario only the Flemish Beauty and a few of the less valuable and often unnamed varieties of pears are very subject to it. Scab is a great drawback to the otherwise valuable variety, Flemish Beauty. When the fruit is badly affected it is cracked open and rendered almost valueless for commercial purposes.

Life History—Very similar to that of the fungus which causes apple scab except for the fact that this fungus is carried over on the twig to a much greater extent.



Pear Scab on fruit. (Original.)



Leaf Spot on pear. (After V. B. Stewart.)

Prevention—The Flemish Beauty pear and other varieties very subject to scab should be sprayed with Bordeaux, (3-6-40), first as the buds are bursting, second just before bloom, third just after the blossoms fall, and fourth in ten days. In very wet weather additional applications may be needed. It is advisable to take special care with the first spray to see that the tips of the twigs are covered. Most varieties of pears require only one application for the control of scab. This should be given soon after the blossoms have fallen with Bordeaux (2-4-40), and either 1½ pounds of arsenate of lead or 1 pound of calcium arsenate to every 40 gallons. A special spray with 3 per cent. lubricating oil emulsion in late March or early April is necessary to control pear psylla (see spray calendar).

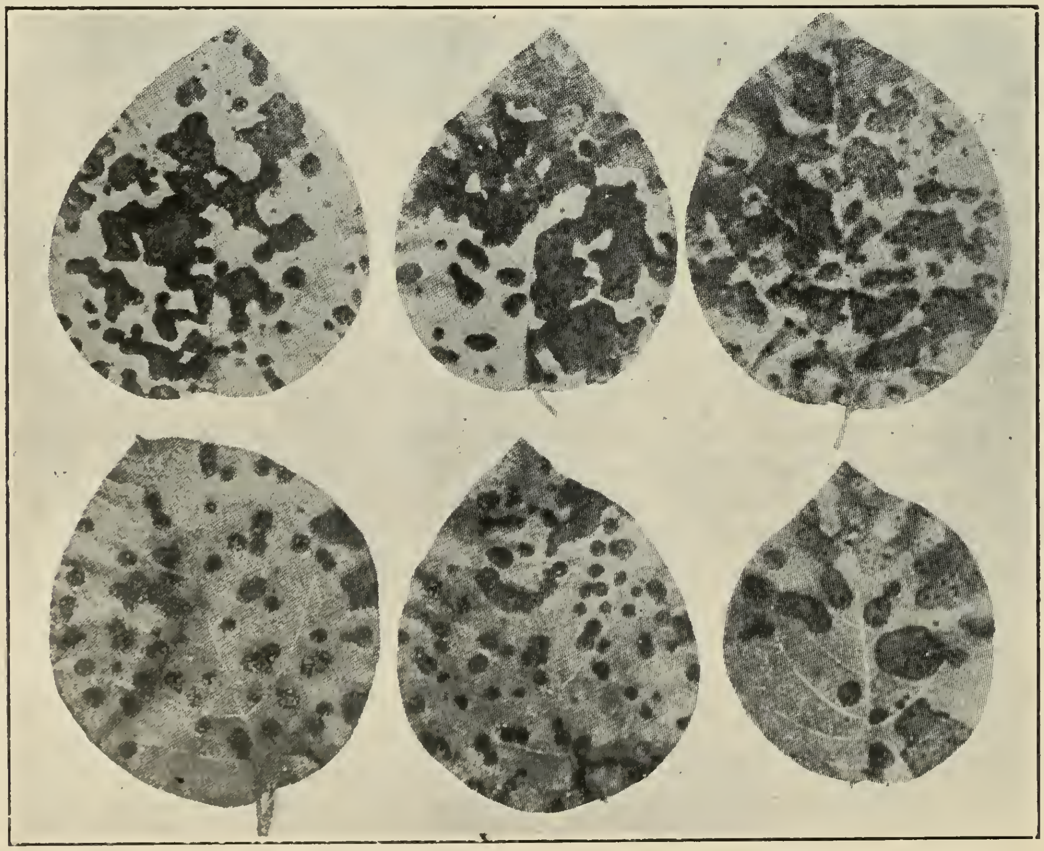
LEAF SPOT OF THE PEAR (*Mycosphaerella sentina* (Fr.) (Schröt).

This disease is frequently seen in Ontario, though it seldom causes any appreciable harm except in badly neglected orchards or to trees growing wild on roadsides or in fence corners. It is sometimes observed in nurseries and occasionally results in premature defoliation which checks the growth of the young trees.

Symptoms—The disease is confined to the leaves, on which are seen small, somewhat angular spots, usually with grey centres and brownish or purplish-brown borders; but sometimes the whole spot is dark in colour, with no distinct grey central area. In the centre of the spots as they mature, small black specks, the fruiting bodies (pycnidia) of the fungus, appear. The size of the spots appear to vary with the variety and the season. When the disease is severe the spots may be so numerous as to injure the leaves markedly.

Life History—The tiny black specks or fruiting bodies (pycnidia) are filled with minute, slender, thread-like spores, which are discharged from a small opening at the tip of the fruiting body (pycnidium). They are scattered through the orchard by the wind and rain, and serve to spread the Leaf Spot during the summer months. Moisture is essential for the germination of these spores and for the penetration of the leaf by the germ-tube. Hence it is that the Leaf Spot is always most prevalent in a wet season. The fungus lives over the winter in the fallen leaves. In these another form of spore (ascospores) is developed in a special kind of fruiting body (perithecium). These are discharged in the spring of the year and some of them are blown by the wind to the newly developed leaves on which in a short time they produce the characteristic spots and the first generation of summer fruiting bodies (pycnidia).

Prevention—The sprayings which are given for Scab appear to control completely Leaf Spot. To control it on nursery stock spraying with Bordeaux mixture (3-6-40) or with commercial lime-sulphur 1 gallon to 40 gallons of water is recommended. The first application should be made just as soon as the trees come into full leaf in the spring, the second about two or three weeks later. In very wet seasons one or two more sprayings at intervals of about two weeks may be necessary.



Leaf Blight of quince. (V. B. Stewart.)

LEAF BLIGHT OF PEAR AND QUINCE (*Fabraea maculata,* (Lev.) Atk.)

This is another disease of comparatively little importance in Ontario. It is seen on both pear and quince, but is usually more noticeable on the latter. It is chiefly a leaf spot disease, but the fruit is sometimes also affected. The spots on the leaves are small circular, dull red or brown in the centre with darker borders. One or more black pimples, fruiting bodies (pycnidia), of the fungus can be seen in the centre of each spot. In severe attacks the spots may be so numerous that the leaves turn yellow or brown and fall. Red and brown spots are sometimes also seen on the fruit. On the quince the disease is sometimes so severe as to cause a premature defoliation.

Prevention—In orchards the sprayings as ordinarily given for Scab appears to control completely this disease on pears. On quinces it may be prevented by spraying with lime sulphur or Bordeaux mixture. Spray with commercial lime sulphur 1 gallon to 40 gallons of water (home boiled lime sulphur sp. gr. 1.007-1.008) or Bordeaux mixture (3-6-40). Give the first application shortly before the blossoms appear and the second soon after they fall. In a wet season a third spraying may be required about ten days later.

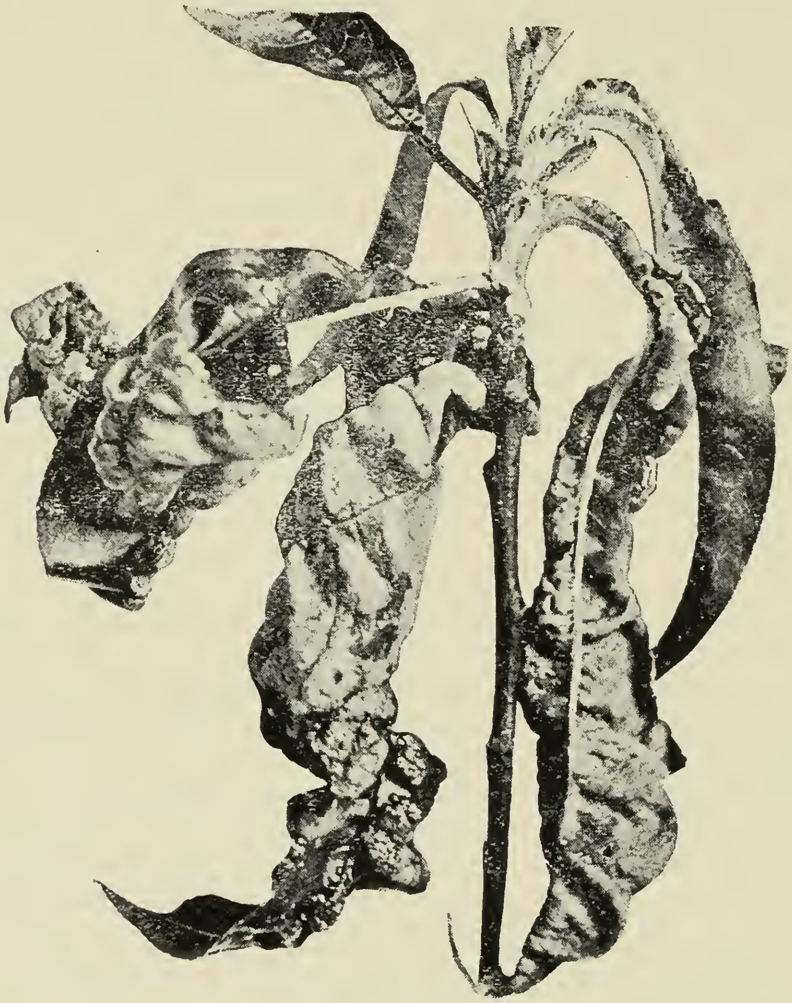
PEACH LEAF-CURL (*Exoascus deformans* (Berk.) Fckl.)

This is the most common and most injurious fungus disease of the peach. It is familiar to every peach grower and very frequently seriously impairs the vitality of his trees.

Symptoms—Blossoms, young fruits and twigs are sometimes affected but it is by the destruction of the leaves that the chief injury is done. The leaves are usually infected before they emerge from the buds in the spring. They become distorted, curled, thickened and yellowish-white, pinkish or purplish in colour. A little later in the season they turn brown and fall. The disease may spread from the leaves into the shoots and destroy them. In severe attacks of Peach Leaf-Curl the trees are almost completely defoliated, the fruit is stunted or drops to the ground, and the vitality of the trees is so impaired that they are likely to be severely injured by the cold the following winter. The proper development of fruit buds is also prevented. Young trees may be killed the first year they are set out if they are defoliated before they have recovered from the shock of transplanting. Peach Leaf-Curl is always more severe in cold wet springs.

Life History—On the surface of the affected leaves numerous spores are produced and the fungus which causes Peach Leaf-Curl is thought to be carried over the winter by some of these spores adhering on or between the bud scales. In the spring, when the buds begin to swell with warmth and moisture, the spores germinate and infect the unfolding leaves. Hence the necessity for early and thorough spraying. In cold wet springs the opening of the buds is retarded, while the germination of the spores and the development of the fungus is favoured by the excessive moisture and not retarded by the cold. Thus the fungus has plenty of time to get established in the tender tissues of the developing leaf. This explains why Peach Leaf-Curl is always worse in cold wet springs.

Prevention—Spray in March or early April before any buds swell, with lime sulphur 1 gallon to 15 gallons of water (sp. gr. 1.020) or with lubricating oil emulsion and (3-6-40) Bordeaux mixture. Spraying must be done early in the spring before the buds have started to swell, and care must be taken to see that every bud is thoroughly covered. Success depends upon early thorough spraying as can be understood from a consideration of the life history of the fungus. Fall spraying for the prevention



Peach Leaf-curl.

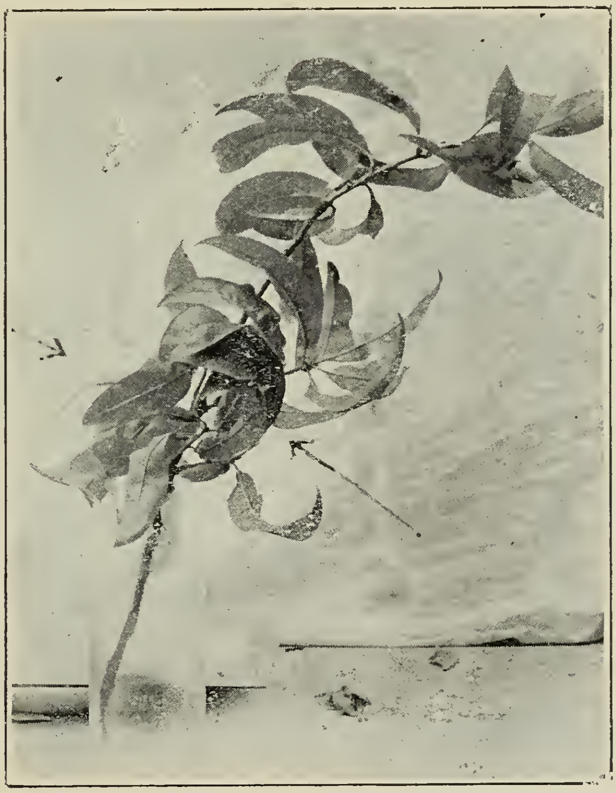
of Peach Leaf-Curl has been tried in Ontario and although it does prevent the Curl we cannot recommend it as it appears to make trees more liable to winter injury.

PEACH YELLOWS AND LITTLE PEACH.

These two diseases are closely associated in the orchard and seem to be so nearly related that they may be discussed together. They are both very destructive and are much feared by all peach growers who have had an opportunity to see the damage they can do. From about the year 1909 to 1913 these diseases were so prevalent in the Niagara district that there was something like a panic among the growers lest the peach industry might soon be ruined. At that time the writer saw several otherwise excellent orchards varying in size from 500 to 1,000 trees, in which almost every tree was diseased and thus worthless; for there is no cure for a tree once it is diseased. Some of these orchards were not more than eight years of age, and so had not reached their prime. Fortunately, a better knowledge of the symptoms of the disease and better inspection have since brought both under control.

Symptoms of Peach Yellows—On a diseased tree some of the fruit will usually ripen from a few days to two or three weeks prematurely.

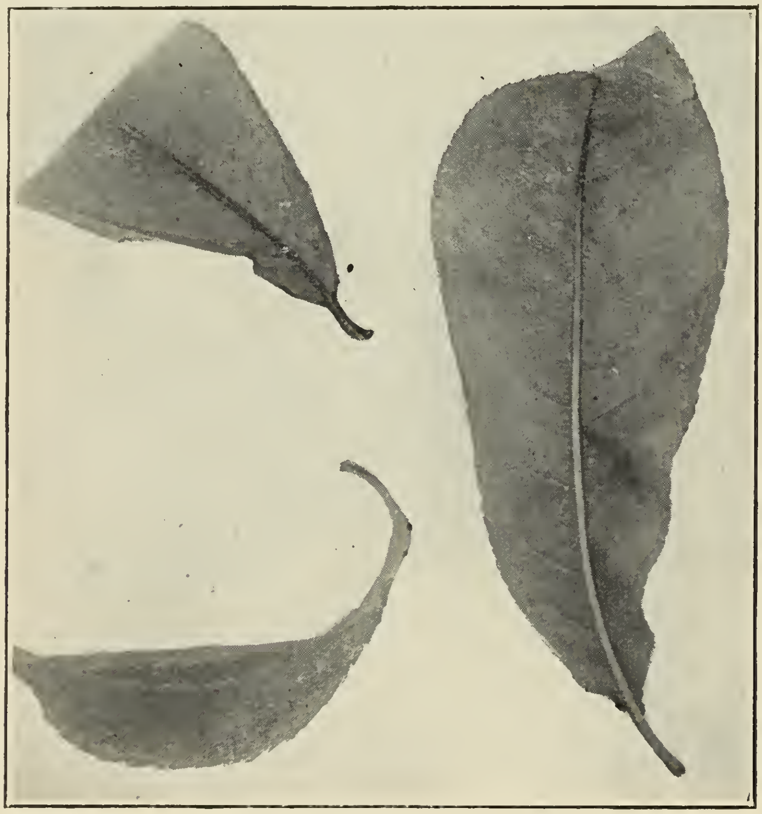
Such fruit is usually more highly coloured than normal, is often blotched outside with red, streaked inside with the same colour and has the flesh around the pit abnormally red. It may also be knobby. Sometimes only one branch or even one twig will show these symptoms and all the rest of the tree bear quite normal fruit. The first year the diseased fruit is either normal in size or a little larger, but the next year it is smaller than normal. The foliage on at least some of the branches is nearly always a sickly yellow colour and is often clustered and curled as described below for Little Peach. Sometimes we find arising from the main branches little upright tufts of much-branched twigs with narrow, yellowish leaves. These broom-like growths, however, are not common except on trees in which the disease is in an advanced stage.



Branch of tree affected with Little Peach just beginning to show the clustering and curling of the leaves near the base as indicated by the arrows. (Original.)

Symptoms of Little Peach—The fruit on a typical diseased tree or part of a tree ripens later than usual, and is smaller than normal, but has no peculiar colour markings. In many cases, however, we find trees on which the fruit ripens at the usual time and is about normal in size, and yet the foliage shows clearly that the trees are diseased. The symptoms on the foliage are the curling and clustering of the leaves, *especially on the inner parts of the tree,* and the sickly yellowish or often reddish-yellow colour they assume. On some varieties the leaves cluster much more than on others. Curling and clustering of leaves apart from the yellowish colour is not a symptom of the disease. On young diseased trees the leaves on the outer branches will usually remain quite green for a long time after those on the inner or central portion have begun to show the disease. If the centre of the tree looks healthy but the outer branches because of a reddish-yellow colour, look diseased, it will nearly always be found that such trees are not affected by Little Peach or Yellows, but are suffering from lack of nourishment. Care must of course be taken both with Yellows and Little Peach not to confuse the foliage symptoms of these with those caused by winter injury or by borers at the base of the tree or by cankers on a branch or elsewhere. A little study and experience will soon enable a person to recognize injuries from these causes. It is also worth remembering that the foliage on the Crawford type of tree differs from that on the Elberta, and the latter again from that on the Smock or Triumph or St. John; so that to study Yellows and Little Peach one should first familiarize himself with the different kinds of foliage to be found on the different varieties. This is especially important as the amount of curling and clustering due to these diseases depends largely upon the sort of leaf characteristic of the particular tree affected.

Cause—The cause of Yellows or Little Peach has not been discovered. There are, of course, several theories, but none is satisfactory. No organism, whether bacterial or fungus, so far as the microscope or as cultures are able to reveal it is present. It is believed, however, to be caused like mosaic diseases by a virus of some kind.



Leaves from Little Peach tree, showing the characteristic flattening and curling. (Original.)

It has been shown both in our own experiments and in those of several investigators in the United States, that these diseases can be produced in healthy trees by budding them with buds from infected trees. We have done this in many cases, both on large and small trees, and in the vast majority of instances, though not in all, the disease has developed. In all but one case in our experiments it required two years from the time the buds were inserted before the symptoms could be detected on the foliage or fruit. Hence it is clear that in the tree itself development of the disease is very slow.

It has been claimed by several writers that pits from diseased trees will not grow. In our experiments this was true only of pits from badly diseased trees, but not of those from trees which had shown symptoms of the disease only for a month or so. Of these, as high as eight per cent. germinated and grew.

It has also been claimed by certain writers that if a pit from a diseased tree grows, the tree thus produced will be diseased. We have had several hundred such pits grow and at the end of three years they showed no sign of disease. So that it would appear as if the danger from pits was not an important factor.

There is good reason to believe that whatever be the cause of Yellows and Little Peach, there is much danger of the disease in some mysterious way passing from one tree to another in the orchard. It is true that for several years this may not happen, and the explanation may possibly lie in the nature of the weather or absence of certain insects some years compared with others. In any case we can see no other explanation of the great increase of the disease in the past in orchards where infected trees were not removed than that these trees spread the disease to healthy trees. It is quite possible that, as in the case of mosaic diseases, aphids may be the spreading agents but this has not yet been proven.

Methods of Control—There is just one method of control, and that is to encourage the local inspector or the grower himself, to mark every clearly diseased and suspicious tree and take it out and burn it promptly. This in Ontario has resulted already in a very rapid decrease. In the Niagara district in 1911, 60,000 trees were marked and destroyed; in 1912 these were reduced to 25,000, in 1913 to 7,000 and in 1914 to 3,000. There are now about 1,000 trees removed each year for Yellows and Little Peach.

Nurserymen also can help to keep down the disease by special precautions not to take bud sticks from a diseased tree or even from any orchard where considerable disease has appeared at any time during the preceding three years.

It should be remembered that cutting out of the branches that show the symptoms is no cure; because once the disease is on one part of a tree it is also in every other part even though the symptoms may be absent.

BROWN ROT OF STONE FRUITS.

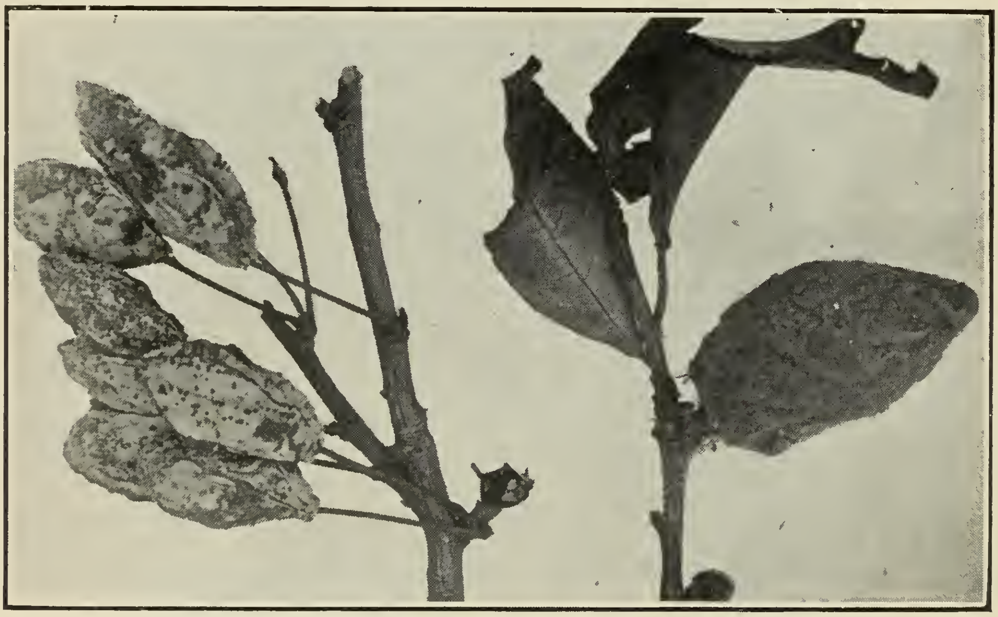
(*Sclerotinia cinerea* (*Bon.*) Wor.).

This, as the name implies, is a disease of peaches, cherries, plums and apricots. It is to be seen in Ontario to a greater or less extent every year, and in some seasons causes very serious damage, especially to certain susceptible varieties of peaches, to sweet cherries, and several varieties of European plums.

Symptoms—Blossoms, fruits, leaves (sweet cherries), and twigs are affected. It is by the destruction of the fruit that the chief loss is caused. It first appears as a small, brown spot which gradually increases in size until the whole fruit becomes soft, brown and rotten. These rotten fruits retain their form for a time but finally they dry out and become shrivelled, hard and wrinkled and are known as "mummies." These are frequently seen hanging on the trees or lying on the ground underneath. On the surface of the rotten fruits greyish-brown, velvety spore pustules are easily seen with the naked eye. The fruit becomes more subject to rot as it approaches ripeness. Sometimes, however, the young green fruits are destroyed by the disease. The blossoms are sometimes attacked. They turn brown and fall. Blossom rot is quite common on cherries and peaches in Ontario. Sometimes the fungus which causes the rotting of the fruit or blossoms grows back into the twigs and girdles them and thus causes a twig blight. This is most frequently seen in the case of certain susceptible varieties of peaches but is not uncommon on cherries and plums. On sweet cherry leaves, brown dead areas due to this disease are common when the rot is bad on the fruit.

Life History—The fungus which causes the disease is spread during the summer months by means of spores produced in great numbers on the surface of the rotting fruits. These are scattered by rain, wind, insects and other agencies. In warm, muggy weather the rot is spread by them very rapidly, especially when the fruits are close together and the foliage so thick as to keep out light and prevent the free circulation of the air.

The fungus which causes the disease is carried over the winter in various ways:—



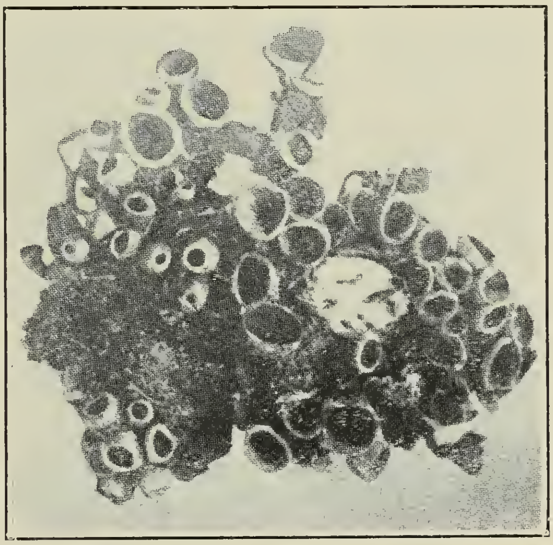
Mummified plums and peach, due to Brown Rot. About one-half natural size. (Original.)

1. By means of the mummied fruits hanging on the trees or lying on the ground beneath. In these the mycelium of the fungus remains alive all winter and in the spring, when they are soaked by rains, the fungus threads may grow again and produce fresh crops of spores (conidia) on the surface. From some of the mummied fruits lying on the ground underneath the trees partly covered by the earth, about blossoming time, little trumpet-shaped growths (apothecia), are produced. These contain immense numbers of another kind of spores (ascospores), which are discharged into the air and may be blown up into the trees, where, if weather conditions are favourable, they may infect the blossoms or young fruit and cause them to rot. These trumpet-shaped growths (apothecia) have been observed in Ontario every year since 1912, and probably play an important part in initiating the disease in the spring.
2. By means of spores produced during the summer adhering to the mummied fruits and probably to bark and bud scales. These retain their vitality and are capable of causing infection and producing disease again in the spring.
3. To some extent by means of dormant fungus threads (mycelium) in the blighted twigs.

It will be seen from the above account of the life history of the fungus, that the mummied fruits are chiefly instrumental in perpetuating the disease from year to year.

Prevention—Prune the trees so as to let in light and air and to facilitate spraying. Peaches should be sprayed first, in March or early April before any buds swell, using lime sulphur, 1 gallon to 15 gallons of water (sp. gr. 1.020) or 3 per cent. lubricating oil emulsion and (3-6-40) Bordeaux. Spray early varieties of peaches subject to Blossom and Twig Blight with Dry Mix (wettable sulphur) when the buds are showing pink. About a month before picking time spray all varieties with Dry Mix (wettable sulphur) or dust with sulphur two weeks before picking.

Cherries—Spray sweet varieties first, just as the buds are bursting, with lime sulphur, 1 gallon to 15 gallons of water (sp. gr. 1.020) and ½ pint of nicotine sulphate (40 per cent.) to 40 gallons, or use a 3 per cent. oil emulsion with (3-6-40) Bordeaux. On sour varieties use lime sulphur 1 gallon to 40 gallons of water (sp. gr. 1.007—1.008) or (3-6-40) Bordeaux. A second spraying should be given to all varieties when most of the shucks are off with lime sulphur 1 gallon to 40 gallons of water (sp. gr. 1.007—1.008) with 3 pounds hydrated lime and either 1½ pounds arsenate of lead or 1 pound arsenate of lime (calcium arsenate). Always put the lime in the tank before adding the poison. If the weather is very wet at this time substitute Bordeaux (3-6-40) for the lime sulphur to control Leaf Spot. A third spraying should be given as soon as the early varieties begin to colour with lime sulphur and poison as in the second spray. In wet seasons additional sprays are absolutely necessary for the prevention of rot. If the weather is very wet during blossom, spray at once with lime sulphur, 1 gallon to 50 gallon of water. Do not add any poison at this time. In a wet or very hot humid season spray again just before the fruit is ripe, using lime sulphur 1 gallon to 50 gallons of water, or the trees may be dusted with sulphur at this time. It is hardly necessary to add that no poison should be used with this application. This last spraying is of the utmost importance in some seasons to prevent sweet cherries rotting on the trees. It prolongs the picking period



Spring stage of the Brown Rot fungus on a peach, buried just at the surface of the ground. (After McCubbin.)

for sour cherries and helps to insure their arriving on the market in good condition.

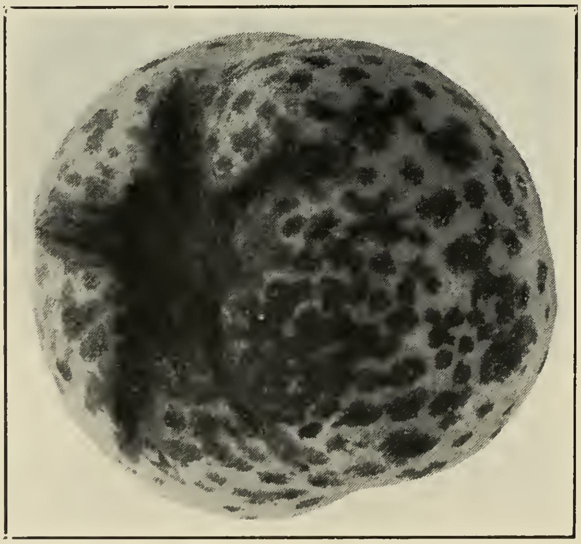
Spray plums first, before or as the buds are bursting, with lime sulphur 1 gallon to 15 gallons of water, or Bordeaux (3-6-40). If red mite or lecanium scale are troublesome add 3 per cent. oil emulsion to the Bordeaux. A second spraying should be given as soon as most of the shucks are off with lime sulphur 1 gallon to 40 gallons of water (sp. gr. 1.007—1.008). Add 3 pounds of hydrated lime and either 1½ pounds of arsenate of lead or 1 pound of arsenate of lime to each 40 gallons. Give a third spraying twelve days later with the same mixture as used in the second spray. Varieties of plums which are very subject to rot should be given an extra spraying about ten days before the fruit ripens with lime sulphur 1 gallon to 50 gallons of water (sp. gr. 1.006). No poison should be added at this time.

PEACH SCAB.

(*Cladosporium carpophilum*, Thum).

This disease has been very prevalent in Ontario during the past two or three years and in some orchards has caused very marked disfigurement of the fruit.

Symptoms—Small, circular, sooty-black spots are seen on the surface of the fruits. These may be scattered all over the surface or may be more or less confined to certain areas. In severe infections the spots may be so numerous as to disfigure badly the fruit and occasionally to cause cracking. Twigs and leaves are sometimes affected, but seldom to a noticeable extent in Ontario.



Peach Scab—a very severe infection.
(Original.)

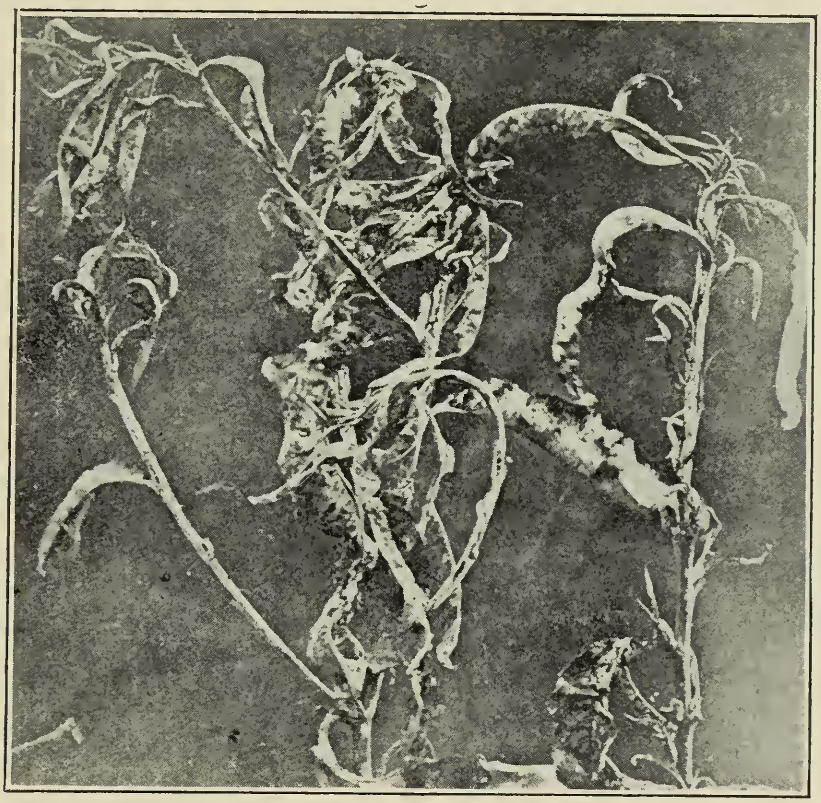
Life History—The fungus which causes the Scab winters over as dormant fungus threads (mycelium) in the twigs. In the spring these fungus threads produce spores in little pustules. These are scattered by wind, rain and insects, and infect the fruit and leaves.

Prevention—Varities subject to Scab or Black Spot should be sprayed with Dry Mix (wettable sulphur) or dusted with sulphur two weeks after the fruit is set and again in two weeks.

POWDERY MILDEW (*Sphaerotheca pannosa* (*Wallr.*) *Lev.*).

This Mildew attacks both the rose and the peach. It is most commonly seen on young peach trees which have not yet come into bearing, and frequently injures nursery stock severely. It does, however, sometimes occur on older trees. Certain varieties are particularly susceptible to it.

Symptoms—The Mildew is seen on the leaves, young shoots and sometimes on the fruit. The leaves become stunted, curled, pale, sickly, more or less folded lengthwise and covered with a dense powdery white substance, which extends over the twigs on which the leaves are borne. The Mildew is easily recognized by this dense white powdery covering on the affected leaves and shoots. It develops most vigorously in warm, moist weather, and is usually most abundant in late summer and autumn.

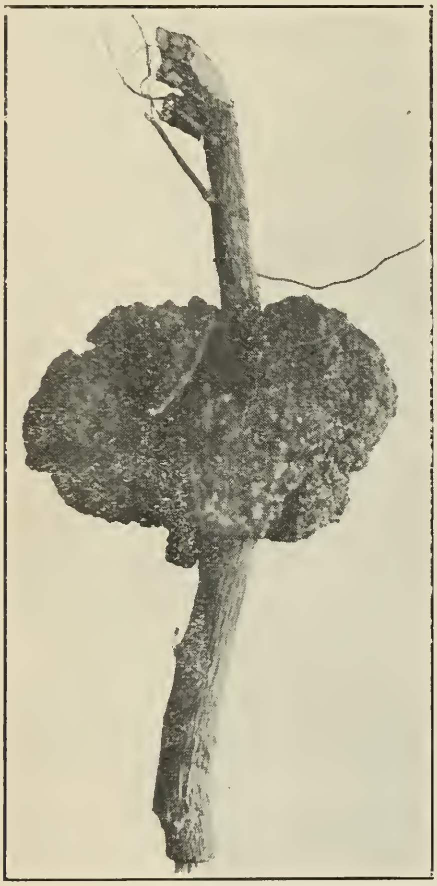


Powdery Mildew on young peach twigs in nursery. Note the distorted, slender leaves, almost white with the fungus spore masses. (After Duggar.)

Prevention—At the first sign of the Mildew, dust with sulphur or spray with Dry Mix (wettable sulphur) and repeat at intervals of ten days as often as may be required to hold the disease in check.

CROWN GALL (*Pseudomonas tumefaciens* (Erw.) Smith & Townsend).

This is a bacterial disease which affects peaches, apples, plums, cherries, raspberries and many other plants. It is easily recognized by the woody, knot-like swellings seen on the trunk and roots. These galls vary in size. Some are not as large as a walnut, while some may be as large as or much larger than a man's fist. When these galls are on the trunk they are usually at or just below the ground. The extent of injury done to the tree by Crown Gall is an open question. Many affected trees continue to grow and appear to thrive normally. There is no doubt, however, that some trees are weakened and stunted, if not killed by the presence of the galls. Hairy Root of apples, often seen in nursery stock and easily recognized by the tufts of thread-like rootlets replacing the branches on the main root, is caused by the same organism.



Crown Gall on Apple. (Original.)

Prevention—In order to be on the safe side do not plant any trees showing indication of Crown Gall. Such trees should be returned to the nurseryman with the request for healthy trees to take their place. It is not advisable to plant fruit trees where raspberries have been grown, as raspberries are very subject to this disease. Care should be taken not to injure the crown and root of fruit trees as it is chiefly through wounds that the bacteria enter them. Trees that are so badly affected with Crown Gall as to be unprofitable should be removed. In the nursery seedling trees showing any signs of Crown Gall should never be used for budding or grafting purposes. Experiments conducted in the United States indicate that it is advisable to dip grafts in organic mercury solution (semesan) or Bordeaux mixture (i) after grafts have been well fitted and carefuly wrapped; (ii) just before planting.

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*A Method for Control of Crown Gall in the Apple Nursery, U.S.D.A. Circular 376.

CANKERS OR GUMMOSIS OF PEACH TREES.

In certain localities in the Niagara district, especially at Queenston, Niagara-on-the-Lake, St. Catharines, and in several orchards at Winona and Grimbsy, it is a common thing to see large, black, gum-covered cankers, chiefly on the upper side of large branches. These cankers do not heal over but continue to widen out and enlarge until finally the whole branch dies. This usually takes several years.

The cankers have been attributed to various causes. Mr. W. A. McCubbin, of the Dominion Laboratory, who has made a special study of Peach Cankers, writes as follows concerning their origin:—

*"1. A very small percentage arise from holes made by borer larvæ.

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*Bulletin 24, Dominion Department of Agriculture, "Fruit Tree Diseases of Southern Ontario."

"2. They may come as an after-effect from small-cracks in the trunks or limbs. The percentage thus found is also very small.

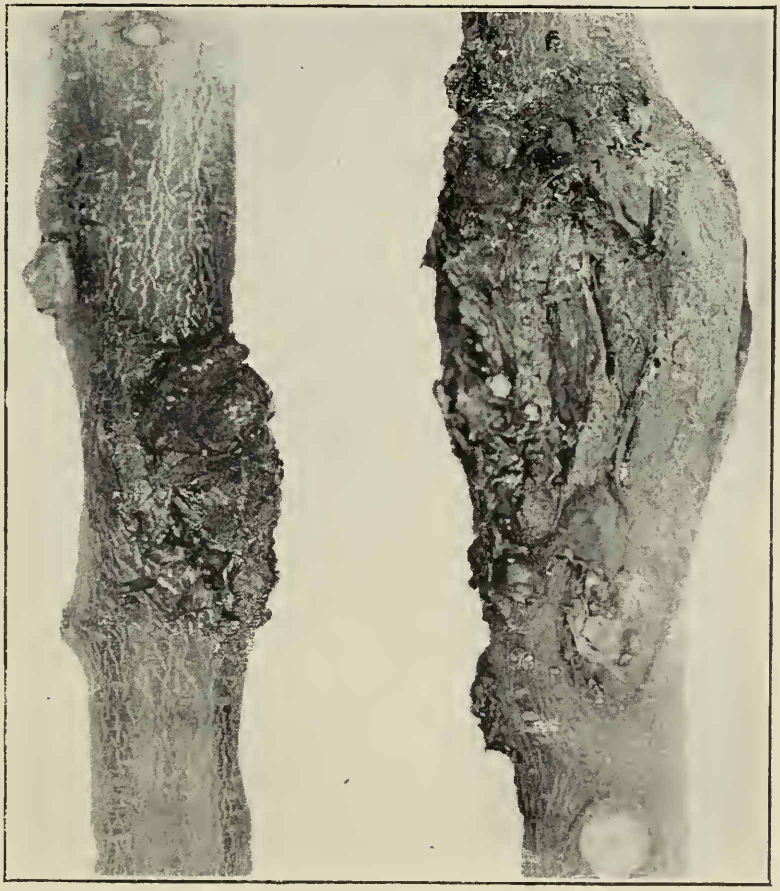
"3. A small number start from gum blisters under the bark.

"4. A few arise at the bases of twigs killed by Brown Rot. The Brown Rot fungus works back from the rotten fruit into the twig and then starts a canker in the larger limb.

"5. Wounds made by scraping the limbs, etc., are accountable for a small number.

"6. Quite a few cankers start at pruning wounds.

"7. By far the greatest proportion of cankers are formed on the limbs at the bases of dead twigs. There is presumably a fungus concerned here which, after establishing itself in the dead twig, runs back into the larger limb and there starts a canker."



Small cankers on peach branches. Natural size.
(Original.)

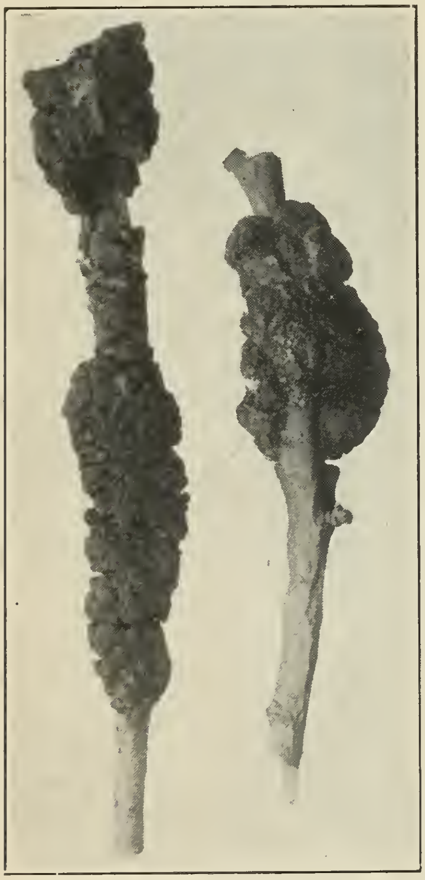
Field observations made by the writers incline them to think that heavy pruning and heavy fertilizing, in combination with winter killing of bark and with wet weather early in the growing season, may also have some effect in inducing the formation of cankers.

Means of Control—Mr. W. A. McCubbin, after conducting many experiments on the healing of Peach Cankers, makes the following recommendation in regard to their prevention and control: Removal of the dead twigs from the main limbs, since it is found that these twigs are the starting point of the disease in such a large number of cases; destruction of Brown Rot mummies; painting of all the larger pruning wounds; removal of small limbs showing cankers, and the treatment of cankers on trunk or large limbs by cleaning out the cankers immediately after rain when the bark and gum are soft, and disinfecting the wounds with formalin diluted one to ten, or corrosive sublimate, one in a thousand, and coating them with lead paint free from turpentine.

The field observations of the writers recorded above indicate that care should be taken not to over-prune or over-fertilize peach trees, as such treatment apparently tends to induce the formation of cankers.

BLACK KNOT OF PLUMS AND CHERRIES, (*Ployrightia morbosa* (Schw.) Sacc.).

This is an extremely destructive disease, and in localities in Ontario where no special efforts have been made to control it, it has destroyed numerous cherry and plum trees. In well-cared-for orchards, it is kept under control and seldom causes serious injury. This is particularly true of orchards in the fruit-growing sections where spraying is generally practised and where the law requiring the cutting out of Black Knot is enforced.



Black Knot on plum twigs. (Original.)

Symptoms—The knots usually appear first in the spring of the year. The swellings are at the start slight, but gradually increase in size. The surface becomes cracked and covered with a light green coating consisting of numerous fungus threads (mycelium) and spores. The swellings are often spindle-shaped and usually confined more or less to one side of the twig. Later in the season, as the knots mature, they lose their green colour and become dry, hard, black and cracked, with the surface studded with minute black pimples which are the fruiting bodies (perithecia) of the fungus. The knots are most abundant on the twigs and smaller limbs, but are sometimes found on the larger limbs, especially in the crotches. Occasionally they occur on the trunks.

Life History—From late spring until midsummer numerous spores are produced on the young, developing knots, so that each is a source of infection to healthy limbs on the same tree or on other trees in the neighbourhood.

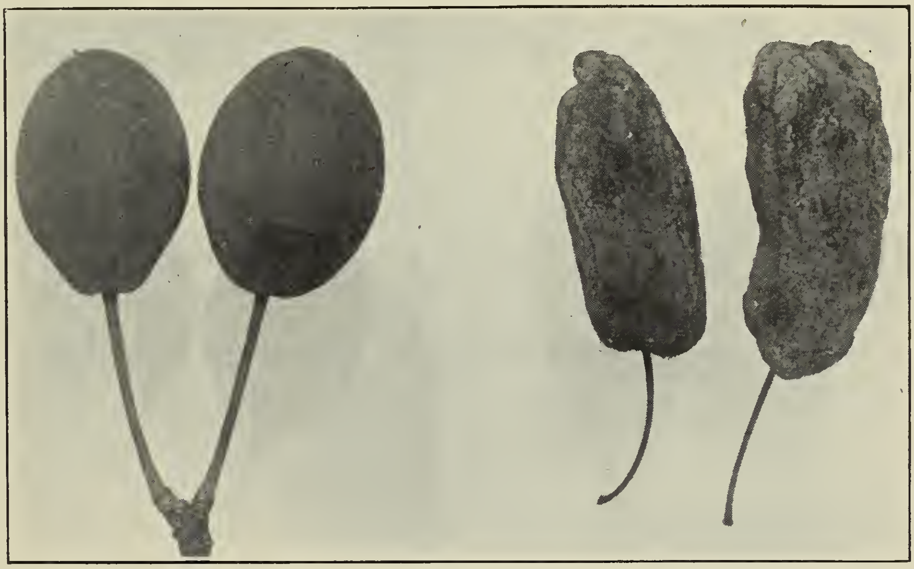
During the fall and winter another form of spore (ascospores) developes in the black pimples (perithecia) on the surface of the mature knots. These spores are mature and are discharged from late winter until early spring, according to the locality and severity of the season. Many of the knots are also perennial, producing fresh crops of spores each year.

Prevention—Cut out and burn the knots, taking care to cut well below the diseased area. This should be thoroughly done at least twice a year, in the fall or early winter and in late spring.

Spray plums and cherries as recommended for Brown Rot. Take special care to see that the first spraying is very thoroughly done. The branches, main limbs and trunks should be covered with the solution at this time. Black Knot attacks wild cherries and plums and there is a possibility of it spreading from these to cultivated varieties. It is advisable therefore to destroy wild plums and cherries in the neighbourhood of the orchard if they are affected with Black Knot. The enforcement of the clause of the "Fruit Pests Act" regarding the cutting out of Black Knot should make it much easier for fruit growers to keep Knot out of their orchards.

PLUM POCKETS, (BLADDER PLUMS) (*Exoascus pruni* Fuckel).

This disease is common in Ontario on wild plums and on cultivated plums of the American varieties (*Prunus americana and P. nigra*). It is recorded also as sometimes occurring on the common or European plums (*Prunus domestica*). It is most prevalent in cold, wet springs. It cannot, however, be regarded as a disease of any great economic importance.



Plum Pockets or Bladder Plums. The fruit on the left is healthy, that on the right is diseased. (Original.)

Symptoms—Soon after the fruit is set it becomes swollen, hollow, without a pit or stone, and often distorted in shape. These light, hollow, bladder-like fruits have suggested the common name "Bladder Plums."

In the early stages, affected fruits are yellowish or reddish in colour. Later they become covered with a whitish bloom. This is due to the production of numerous spore sacs (asci) on the surface. These sacs (asci) contain ascospores. After these are discharged the fruit turns dark brown in colour and falls off.

Life History—The fungus which causes Plum Pockets appears to live over winter as spores, adhering on or between the bud scales. These germinate and produce infection of the young ovaries when the buds are bursting in the spring.

Prevention—Spraying as recommended for Peach Leaf-Curl appears to prevent this disease entirely.

LEAF SPOT, SHOT-HOLE FUNGUS, YELLOW LEAF DISEASE OF CHERRIES.

This is a very common and an exceedingly serious disease in Ontario. It is seen on wild and cultivated cherries and plums. It does most damage to cherries. Both sweet and sour cherries are frequently completely defoliated by it in wet seasons. In the years 1915, 1916 and 1928 it was particularly bad. It is usually regarded as doing most damage to sweet cherries but here in Ontario it has been just as destructive if not more so to sour cherries.

The disease on the different species of cultivated and wild cherries and plums is not all caused by the same fungus. Three closely related species of Fungi, each confined to certain species of cherries or plums, have been found to cause it. Coccomyces hiemalis, Higgins, causes the disease on sweet and sour cultivated cherries and on the wild pin cherry, C. pruniphorae, H. on cultivated plums of the European and American varieties and on two species of wild plum, C. lutescens, H. on wild black cherry, choke cherry and perfumed cherry.

Symptoms—These vary with different hosts. On the leaves of plums and wild cherries brown spots are produced, some of which soon fall out, leaving little holes, which give the leaf a "shot-hole" appearance. On cherries the spots on the leaves do not as a rule drop out so readily and are smaller. They are reddish-brown in colour and may be very numerous, so that nearly the whole surface of the leaf may be covered by them. Badly affected leaves turn yellow and drop. Cherry trees are frequently completely defoliated early in the summer. Such defoliation prevents the proper ripening of the wood and renders the tree very subject to winter killing. In the spring and summer of 1916, numerous instances were recorded of cherry trees not surviving the winter. When inquiries were made, it was found in nearly every case that the trees which were winter-killed had been defoliated by Leaf Spot the previous summer.

Life History—On the surface of the spots on the leaves numerous spores are produced. These can often be seen as little white, velvety pustules in the spots, usually on the under side of the leaf. These spores serve to spread the disease during periods of wet weather in the summer. Moisture is necessary for its spread. It is only in wet seasons that it causes serious injury. The fungus which causes the disease is carried over the winter in the fallen leaves. In these it produces fruiting bodies (apothecia). These contain another form of spores (ascospores). During wet weather in the spring, about the time the new leaves are developing, these spores are discharged from the fruiting bodies in great numbers. Some of them are carried by the wind to the young leaves, where they produce the first infection of the season, from which the characteristic spots develop a week or two later.

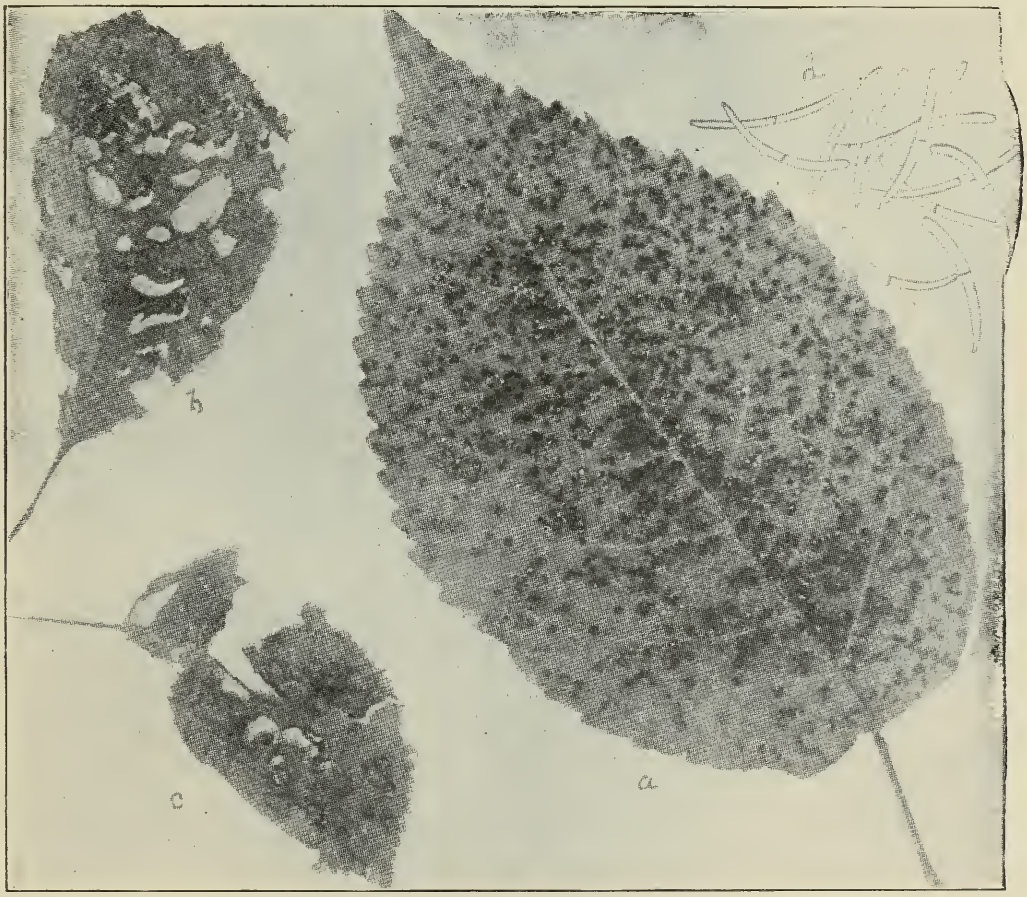
Prevention—Spray with Bordeaux mixture (3-6-40) when most of the shucks are off and add either 1½ pounds of arsenate of lead or 1 pound of arsenate of lime. In ten or twelve days spray again with Bordeaux and poison as above. Give a third spraying ten or twelve days later with lime sulphur, 1 gallon to 40 gallons of water (sp. gr. 1.007-1.008), 3 pounds of hydrated lime and either 1½ pounds of arsenate of lead or 1 pound of arsenate of lime (calcium arsenate). Put the lime in the spray tank before adding the poison.

POWDERY MILDEW OF CHERRY (*Podosphaera oxyacanthae* (*D.C.*) DeBary).

This Mildew is frequently noticed on cherries in Ontario. It does not usually injure old trees to any great extent. Young trees and nursery stock, however, are sometimes severely injured by it. Apples and plums are also affected by the same mildew, especially nursery stock.

Symptoms—The young shoots, tips of branches and leaves become covered with a white powdery mildew. On the leaves it is most abundant on the lower surface. In severe attacks shoots and twigs are distorted and stunted and the leaves curled. Early in the season the mildew is white and more or less powdery, especially on young shoots and twigs. Later it becomes darker in colour. If the mildew on the lower surface of a leaf is examined at this time, numerous dark specks will be seen scattered among the white threads. These impart the darker colour to the mildewed areas.

Life History—On the surface of the leaves and shoots the white threads of the fungus (mycelium) can be seen with a hand lens. During the early summer from these white threads stalks are sent up which bear chains of spores (conidia). These spores are so numerous that they give to the mildew the characteristic powdery appearance. They serve to spread the disease during the summer months. Towards autumn minute specks are seen among the fungus threads. These are at first yellow, later black in colour. They are fruiting bodies (perithecia), and each contains one large spore sac (ascus) with eight spores (ascospores) inside. These spores serve to carry the fungus over the winter. In the spring they are liberated.



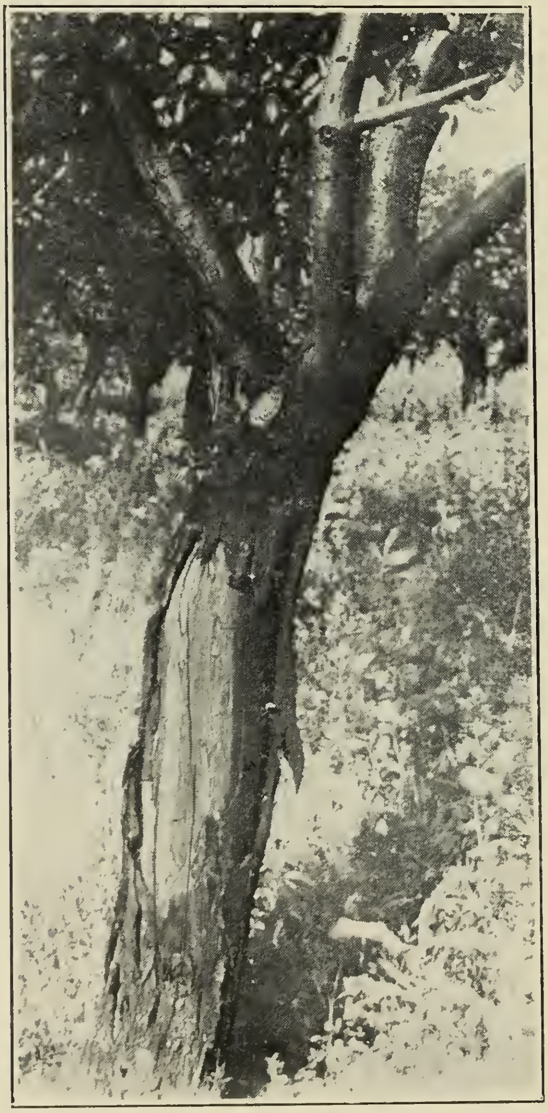
Leaf Spot or Shot-hole Fungus on cherry and plum. (Original.)

Prevention—The sprays recommended for the control of Cherry Leaf Spot usually keep the Mildew under control. If Mildew appears dust immediately with sulphur and repeat the dusting at intervals of ten days until from three to five applications have been made, depending upon the severity of the disease. If a duster is not available spray at the times indicated above with commercial lime sulphur, 1 gallon to 40 gallons of water (sp. gr. 1.007-1.008). The addition of 3 pounds of iron sulphate to 40 gallons of the mixture tends to reduce the possible injury to the foliage and also increase its sticking quality.

INJURIES DUE TO WINTER OR TO LOW TEMPERATURES.

In this province, which is subject to cold winters and great extremes of temperature, winter injury or injuries caused by low temperatures, are common and very important. Hence every fruit grower should have a knowledge of the forms which such injuries take and of the simple means by which some of the worst of them may be prevented.

It is impossible to go into a full account of this subject, so that the following deals only with the more common or more important types of injuries. We have already referred to the winter killing of cherry trees as a result of early defoliation brought about by the Leaf Spot or Shot-hole Fungus disease. Hence this will not be dealt with here.



Effect of Sunscald on the southwest side of the trunk of a European plum tree. Most of the bark on the injured area has been killed and fallen off. (Original.)

SUNSCALD.

This is the most common form of winter injury. It occurs all over the province, but is worst in the colder portions. Thousands of apples, plums and cherries in almost every fruit-growing county are affected. The injury consists in the killing of the bark, often over an area three or four feet or even more in length, on the south or south-west side of the trunks, and also in the case of apples on the upper side of large branches. The death of the bark is caused by its being heated up by the sun's rays on cold, bright days, especially in February and March, and then after sunset cooling off very quickly. The great drop in the temperature thus taking place in a few hours is very injurious to the tissues of the bark and, if frequently repeated, kills them. Sunscald also seems to take place on hot days in summer. To make matters worse, the dead sunscalded area on apple trees is commonly invaded by the Black Rot fungus, which gradually extends the injury and in many cases girdles the trunk or branch and kills all the parts above. Heart rots also may invade the injured area and greatly weaken the trunk. On plums and cherries it is chiefly the trunks that are affected and here, too, the injury may be increased by fungi or by borers working around the margins of the dead bark. Sunscalded trees, of course, often live for many years, and may bear almost as well as if the bark on the affected area had not been killed.

Methods of Control. (1) When setting out new orchards incline the trees a little to the south-west and head them low. This helps to shelter the trunks from the sun.

(2) In dehorning or pruning apple trees, never remove all the centre, thus exposing large branches to the direct rays of the sun. Such open centres are not only unsightly, but lessen the bearing capacity of the tree.

(3) The trunks and branches of Transcendent and Martha Crab apples are very resistant to Sunscald and the roots to root-killing, hence, if these were planted and the desired variety of apples grafted or budded on their branches, much of the danger of Sunscald, Root-killing and Collar Rot would be avoided.

(4) All dead sunscalded areas, especially on the trunks, should have the bark removed with a drawknife, and the wound painted with white lead or with coal tar. This will keep out the Black Rot and other fungi.

(5) The trunks may be protected against the sun's rays by various devices, such as wrapping them with white building paper, or using veneer, or even by tacking a board up against the south side. Whitewashing the trunk heavily about the end of January also helps. If building paper is used and is put on in late autumn and a little earth thrown up around the base, it will also keep off mice. Any form of protection against Sunscald should always be applied not later than about the middle of Jannary.

CROWN ROT OR COLLAR ROT.

This is the name commonly given to that form of injury which consists in the death of the bark around the base of the trunk of trees. The girdling may be either complete (and in such cases the whole tree soon dies) or may be partial, only one side or portions here and there being girdled. In the latter case, the branch or branches directly above the dead bark may die, but often the whole top may remain alive and healthy. There is a great tendency, however, for these semi-girdled trees to become completely girdled after a few years. Crown Rot is fairly common in apple orchards in most parts of the province, and is by no means limited to the colder districts. King of Tompkins is specially subject to it, but many other varieties also suffer.

There are several theories as to the cause of this Collar Rot, but the writer is convinced that the chief cause is low temperatures acting upon succulent tissues which have not been properly hardened up for winter.

The bark at the crown is much more tender than that higher up on the trunk, and hence where trees have been over fertilized or cultivated too late, this is the part that is most likely to be killed, especially if not protected by snow.

The death of the bark around the base of the trunk of peach trees and also of sweet and sour cherries, sometimes extending a short distance below the ground, is closely allied in nature to the Collar or Crown Rot of apples. It is usually found where the trees are in exposed situations or where wind currents sweep through the orchard, especially if the trees were very thrifty the previous summer and fall.

Methods of Control—(1) Do not plant on their own stock King of Tompkins or any other variety known to be very subject to this disease. If these varieties are desired, they should be grafted on immune or nearly immune stock, such as Tolman Sweet or Transcendent or Martha crab apples.

(2) Do not over-fertilize or cultivate so late that the trees will not have their wood and bark hardened up for winter. Cultivation, even in the warmer districts, should close by July 1st, and a week or two earlier in the colder districts. A cover crop should be sown as soon as cultivation is finished. This will help to hold the snow on the ground.

(3) There is much less danger of collar rot under sod mulch conditions than under cultivation.

(4) Never plough away from the trees in autumn, but see to it that the soil around the trunk is high enough so that no water will remain there.

(5) Where trees are only partially girdled, especially apple trees, it is a good plan to remove the dead bark and cover with coal tar the wood thus exposed. Rotten bark favours the entrance of fungi, hence the reason for its removal. The tar keeps out rain and so helps to prevent rot.

(6) If observed early in the spring after it has taken place the dead area may be bridge-grafted much the same way as for mice injuries.

BLACK-HEART.

After a very cold winter or after sudden extremes of temperature even in October or November, apple, pear and peach trees will sometimes on examination be found to have their wood killed and darkened, even though the bark and cambium are still alive. Young trees, including nursery stock, are more subject than old trees to this trouble, but the branches even of old trees may be affected. Where the injury occurs in the same tree a couple of years in succession, or where rot-producing fungi get entrance into the wood through some wound or opening, the tree or branch may become so brittle and weak that it will break off as a result of any slight strain. Such trees are, of course, worthless. Very often, however, trees, especially bearing trees, may be black-hearted, and yet live and bear good crops, though there is a great tendency for large branches to die from time to time. Some varieties of apples and pears are much more subject than others to Black-Heart; in fact the more tender the variety the more subject it seems to be to this disease. Peach trees, owing to the rapidity with which they make new wood, recover more fully from Black-Heart than apples or pears, but many peach trees also die as a result of the injury.

Methods of Control—(1) Do not plant any variety that experience shows is too tender for your district. Baldwins especially should not be planted in the colder portions of the province or in counties subjected to great extremes of weather. Some of the hardiest good varieties of apples are, Melba, Duchess, Wealthy, McIntosh, Fameuse and Tolman. It is only very hardy varieties like these which should be planted in the colder parts of the province.

(2) Avoid late cultivation and over-fertilizing. (See under Collar or Crown Rot.) Yet on the other hand the trees must not be weakened by starvation and neglect. A golden mean is what is desired.

ROOT-KILLING.

Almost every kind of fruit tree is liable to suffer to some extent from root-killing, but peaches, cherries, and dwarf pears grown on delicate quince roots suffer most. This form of injury is usually brought about by a combination of low temperatures and dry weather accompanied by evaporation of moisture from the soil. Hence it is most common in light soils and in situations where the snow blows off and the winds dry out the soil. Prolonged cold periods in a winter when there is little snow and little moisture in the ground are specially favourable to root-killing.

Control—Anything that helps to hold the snow on the ground and prevent evaporation will help; hence a good cover crop, such as rye, is recommended, or a covering of the ground with coarse barnyard manure.

BARK SPLITTING ON TRUNK.

This is moderately common. Fruit growers used to believe that it was due to trees being, as they called it, "hidebound," but it is now known to be caused by a great, sudden drop of the temperature which contracts the bark much more rapidly than the sapwood, with the result that it gives way at some one or more places, and once a rupture occurs the splitting readily extends up and down with the grain of the bark. Deciduous shade trees are also subject to bark splitting. Sometimes the splitting extends into the wood for some distance, but usually it is only the bark that is affected. In some cases the bark is not only split, but is also torn away from the wood for an inch or more on each side of the split.

Methods of Control—(1) Trees that have made a luxuriant growth and are not hardened for winter seem to be most subject to splitting; hence the remarks above on avoiding late cultivation apply here.

(2) If the bark has separated from the wood it will be well to remove it back to near where the union is intact and to paint the exposed wood with white lead. Cracks may be filled with grafting wax to keep out water. Always open the bottom of the injury to make good drainage and let out all water that otherwise would accumulate.

CROTCH INJURY.

In the colder portions of the province many trees are injured during winter at the crotch or fork, the bark at this part being killed. Bark at crotches is apparently more tender than on trunks or branches. If this dead bark is allowed to remain, and if there is not good drainage to carry off moisture, it will not be long until rot-producing fungi will gain entrance and cause the wood itself to decay, with the result that one or more large branches may break off or the whole tree be ruined.

Methods of Control—(1) Hardy varieties are not nearly so subject as tender varieties to this injury, hence in the colder districts too great care cannot be taken to set out only varieties that will be suited to the climate.

(2) When forming the head of young trees, distribute the main branches so that they will not come out together and thus form a weak crotch. It is a good plan to have a central leader or semi-central leader.

(3) Varieties that overbore the previous season are more susceptible to this injury; hence thinning of over-loaded trees would help.

(4) Where crotch injury appears, remove the dead bark and paint the wound with white lead or cover with grafting wax. Never use cement in a crotch, as it will crack.

KILLING BACK OF NEW GROWTH.

It is a very common thing, especially after a severe winter, to find that numerous twigs, especially on peaches, have been killed by winter. The killing may extend two feet or more back from the tip. Trees that made a late growth in summer and autumn are usually the ones that suffer most.

Methods of Control—The general principles in regard to cultivation and fertilizing mentioned under Collar Rot apply here. If time permits the dead twigs should be cut out as soon as observed.

KILLING OF FRUIT BUDS.

Nearly every year many fruit buds on peaches are killed, though the leaf buds are uninjured. This is the chief reason that peaches require a mild climate. Cherry and plum buds, especially cherry buds, are also subject to winter killing, but will usually stand much greater extremes than peaches. The killing of apple and pear buds is not common. If a dead peach bud is cut through with a sharp knife, the centre will be seen to be brown or black; in cherry and plum buds the pistil shows brown.

Bud killing seems to be due chiefly to a sudden great drop or drops of temperature. If the buds have become somewhat too advanced through the occurrence of very mild weather, late in fall or in January and February, their destruction seems to take place more readily.

Methods of Control—The presence of a large body of open water by moderating the climate helps to prevent this injury. Apart from the choice of situation, all that one can do would seem to be to follow the well-known good methods of cultivation, fertilizing and pruning. Good air circulation is also valuable; hence in choosing a site for an orchard avoid air pits or places where the air circulation may be expected to be poor. Air drainage is almost as important in an orchard as soil drainage.

KILLING OF BLOSSOMS AND YOUNG FRUITS.

Late frosts during bloom or soon after may destroy numerous blossoms or even young fruits. The latter seem to be just as tender as the blossoms. Sometimes enormous losses are caused by these late frosts. Orchard heaters are used in some countries to prevent this injury. They have not, however, been much tested in Ontario. The question of sites is important here, as frost is always more destructive where air drainage is poor. It is interesting to know that late-blooming varieties, as Spy, often escape injury, when earlier varieties, like Greening or King or Baldwin, are killed.

Russeting of Fruit and Crinkling and Rupturing of Leaves.

Late frosts, soon after or as the fruit is setting, may result in very conspicuous russet bands around apples and pears. These bands may be at the calyx end, or around the middle or nearer to the stem end. They are probably due to frost and moisture combined injuring the skin.

Some years the leaves are much crinkled and sometimes have the upper surfaces separated from the lower through spring frosts. There is apparently no practical method of preventing such injuries.

Lob-sided Fruits.

In the year 1927 many apples, especially Baldwins, in the western part of the Province, were lob-sided. This was due to a severe frost about the time the fruit was setting. The skin of the young apple was ruptured and in many cases at lease one or more of the carpels were killed. There seems to be no way to prevent such injuries, but fortunately they, like the russeting of the fruit, are rare.

INSECTICIDES AND FUNGICIDES

ARSENATE OF LEAD.
This is the only safe poison on orchard foliage with water alone.

CALCIUM ARSENATE (arsenate of lime.) This costs on the whole only about one-third as much as arsenate of lead per barrel of spray. Its chief defect is that it cannot be used with water alone because of burning. With lime-sulphur it should always have 3 pounds of hydrated lime added to every 40 gallons of spray.

LUBRICATING OIL EMULSIONS.

FORMULA:

Lubricating oil	3 gals.
Bluestone	6 ozs.
Hydrated lime	6 ozs.
Water	3 gals.

Pour the oil into a container or into the spray tank; dissolve the bluestone in half the amount of water; stir the hydrated lime into the other half; pour these two together; then add them to the oil; and pump this mixture back upon itself through the nozzle under high pressure until all the oil is properly emulsified.

Dilute with water to 100 gals., keeping agitator running while doing so. This gives a 3 per cent. emulsion.

Note.—The lubrication oil must have approximately the following characteristics:

Gravity at 60° F.	24 to 26 A.P.I.
Flash point (open cup)	360° F. (minimum)
Viscosity at 100° F.	170 to 220 seconds (Saybolt).
Volatility (loss at 105°-110° C. after 4 hours)	0.41 per cent.
Pour and solid	40°/35° F.

Such oil may be purchased from any large oil company.

CAUTION: Do not use oil sprays when temperature is below 40° F.

BORDEAUX MIXTURE.

Bluestone (Copper Sulphate)	3 lbs.
Hydrated lime or fresh stone lime	6 lbs.
Water	40 gals.

Hydrated lime is much the more convenient form to use, as it can easily be secured and stored and does not require slaking.

Hydrated lime if left exposed to the air becomes worthless, so keep it in tightly fastened paper bags in a dry place.

TO PREPARE BORDEAUX MIXTURE.—Dissolve the bluestone; then nearly fill the tank with water; add the proper amount of dissolved bluestone; start the engine to agitate the liquid; add the hydrated lime or slaked stone lime, and agitate the mixture for about 5 minutes. If a hand outfit is used agitate by pumping the liquid back upon itself for 5 minutes.

Note.—The easiest way to dissolve bluestone in the crystal or lump form is to place 40 pounds of it in a bag and suspend this in a barrel containing 40 gallons of water in such a way that the bottom of the bags sinks only 3 or 4 inches below the surface of the water. Leave over night and in the morning all will be dissolved. One gallon of the liquid will now contain 1 pound bluestone. Small quantities can be rapidly dissolved in boiling water by stirring. Granulated bluestone dissolves very readily and is usually placed in the desired amount upon a burlap screen on the hopper or inlet of the tank and dissolved by the water being poured over it as the tank is filled.

LIME SULPHUR.
The commercial product is commonly used. For directions for making the *home-made lime-sulphur*, consult Bulletin 198, which also contains full directions for testing the mixture and for the use of the hydrometer.

DRY MIX (wettable sulphur) is a commercial product. Follow the manufacturer's directions.

SULPHUR-CASEINATE is a mixture of 8 lbs. sulphur dust and ½ lb. of calcium caseinate to 40 gals. of water.

DUSTS.
There are to-day two classes of dust: 1st, finely ground sulphur and arsenate of lead powder; and 2nd, finely powdered bluestone combined with lime and arsenate of lime. Either of these may be secured without the poison. In addition there are several forms of nicotine dust. Dusting is satisfactory as a supplement to spraying in large orchards, but we do not feel safe in recommending it as a substitute for the liquid spray. If so used apply at the same times as indicated for the liquid spray, but in wet weather give extra applications. Dust when air is calm, as, late in evening or early morning.

Note.—Bordeaux may be used with lubricating oil emulsion or other oil sprays.

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FUNGUS AND BACTERIAL DISEASES OF VEGETABLES

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INTRODUCTION

The object of this bulletin is to furnish all who are interested in the growing of vegetables with information which will enable them to identify the more common fungus and bacterial diseases of vegetables and to apply intelligently the treatments which experience has proved to be the most effective in each case.

In a bulletin of this nature it has been thought wise to include the bacterial with the fungus diseases, in order to place in the hands of the grower a complete and convenient manual of all the more important diseases of vegetables.

The majority of the diseases of vegetables are what are known as fungus and bacterial diseases. It is important that those having to deal with them should understand fully the cause of such diseases in order that they may apply intelligently remedies for their control.

THE NATURE OF FUNGUS DISEASES

Fungus diseases are caused by plants known as fungi. These plants, unlike ordinary flowering plants, have no green coloring matter (chlorophyll) and are unable, therefore, to manufacture their own food. All their nourishment must be obtained from decaying animal or vegetable remains or from living plants or animals. Those fungi which derive their nourishment from living plants in so doing injure them in various ways, and thus give rise to what are known as fungus diseases.

The bodies of fungi which cause plant diseases are usually extremely small and very simple, consisting of very fine, delicate, thread-like structures (hyphae), some of which become modified and produce reproductive bodies called spores, which may be considered similar to the seeds of flowering plants. Sometimes the fungus threads live upon the surface of the plants and obtain their nourishment by sending down little suckers (haustoria) into the cells below. Most frequently, however, they live within the plants, either in or between the cells. Two kinds of spores are usually produced—thin-walled summer spores, which spread the disease during the growing season, and thick-walled resting or winter spores, which serve to carry the disease over the winter. Spores are scattered by various agencies, chief among which are wind, water and insects. On coming in contact with a suitable host plant, they send out little threads (germ tubes), which enter the plants through the little pores on the leaves (stomata), through the skin or through wounds. Once within the plant, these little threads grow rapidly, drawing their nourishment from the cells of the host plant and setting up a diseased condition.

Generally speaking, in combating fungus diseases methods of prevention only are practicable, as once a fungus is within the plant nothing can be done to destroy it. Care should be taken to keep the crops in a healthy growing condition and free from injury by insects. Unthrifty plants and those attacked by insects are more subject to fungus diseases than healthy ones. Rotation of crops should be practised, so that the winter spores left in the soil may not infect the next season's crop. Weeds should be destroyed, as they frequently harbor fungi. Diseased crop refuse should be burned and not thrown on the manure heap. Fresh manure should be avoided, as it frequently contains living spores of parasitic fungi.

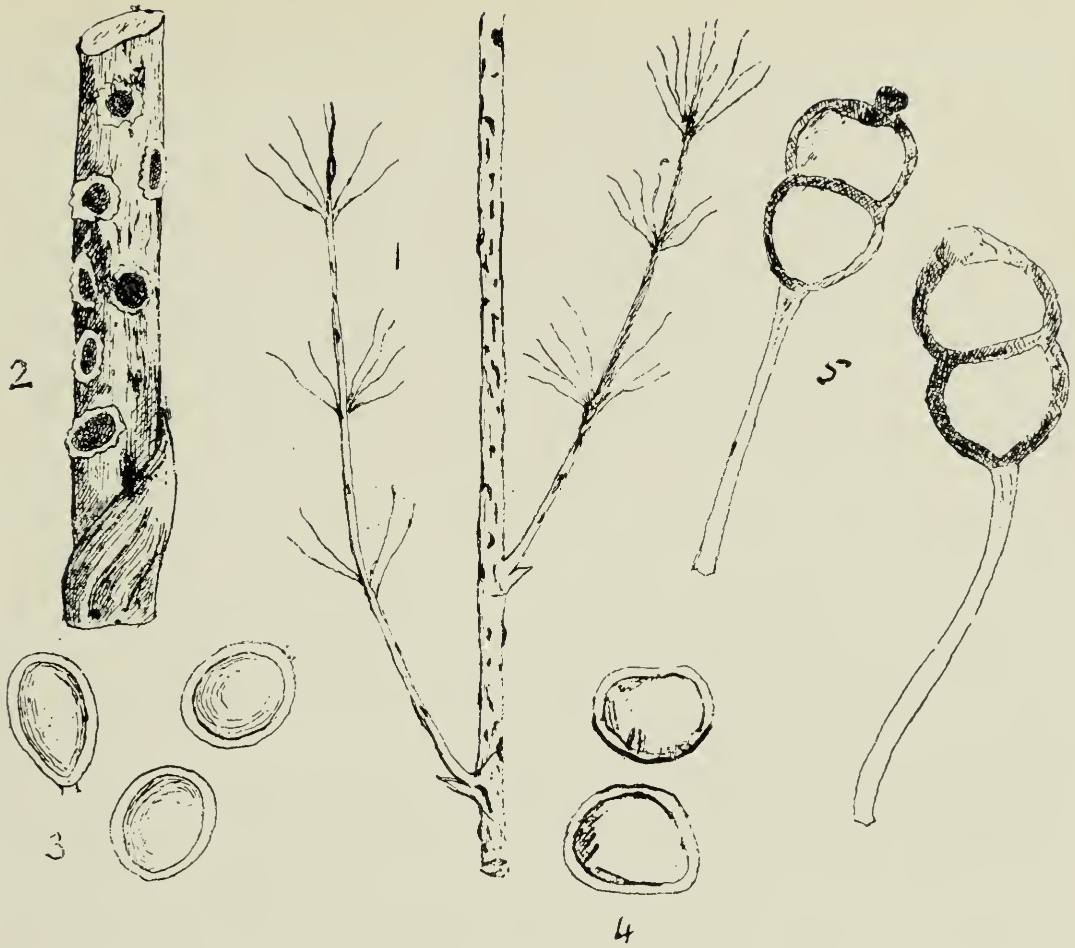
Intelligent and thorough spraying with Bordeaux or other fungicides will do much to prevent the spread of fungus diseases. It should be kept in mind, however, that spraying is done not to cure, but to prevent disease. In other words, the object of spraying is to cover the surface of the leaves, fruits or other parts of the plant with a substance poisonous to the spores of fungi, in which they cannot grow and penetrate the plant. Spraying, therefore, in order to be effective, must be timely and thorough. The spray mixture must be on the plant before the spores reach it, and the surface of the leaves, fruit and other parts of the plant must be covered so completely that there is not the smallest space on which a spore can germinate.

THE NATURE OF BACTERIAL DISEASES

Bacteria are microscopical fungus plants. They are the smallest forms of life known. Their average size is about 1/10,000 of an inch. They multiply very rapidly under favourable conditions, so that one may become anywhere from ten millions to twenty millions in twenty-four hours. There are many kinds of them. Most kinds are useful, particularly in the soil, where they prepare the plant food for the growing crops. Some of them are injurious, however, and among these are those that cause the bacterial diseases of vegetables. When these get into the growing plants, either through wounds made by insects and cultivators or through the water pores or breathing pores of the plant, they feed on the plant juices and bring about a diseased condition such as a soft rot, canker or wilt.

Generally speaking, spraying, which is so useful in checking or preventing fungus diseases, is of little or no use in controlling bacterial diseases. This is because the bacteria which cause disease get inside the plant and the spray only reaches the surface, and therefore does not come in contact with the bacteria. Poison sprays, by killing insects, help to prevent the spread of those bacterial diseases the germs of which are carried by insects.

In preventing or controlling bacterial disease of plants care should be taken, first, to use only seed that has been obtained from crops where there has been no disease; second, whenever a plant in the growing crop is found to be suffering from a bacterial disease, the plant, where practicable, should be carefully removed and burned, because as long as it is left standing in the crop it serves as a centre from which the germs of the disease may be carried to healthy plants by insects, slugs, caterpillars, cultivators or the hands of operators; third, refuse from diseased plants should not be ploughed into the soil or thrown on the manure pile or compost heap, but should be carefully gathered and burned; because the disease bacteria in such refuse are liable to live over winter and cause trouble next season.



Asparagus Rust.

1. Attacked stem showing spore clusters.
2. Cluster-cup form.
3. Spores from cluster-cup.
4. Spores from summer stage. (*urediniospores*).
5. Resting or winter spores. (*teliospores*).

ASPARAGUS RUST

This disease is often seen in Ontario. Before the advent of varieties of asparagus resistant to rust it frequently severely injured asparagus in many parts of the Province.

Symptoms. There are three distinct stages of this disease. The first is known as the cluster cup stage or the spring form. It appears on the young shoots shortly after they come above the ground. On these are seen orange-yellow or greenish yellow cup-shaped pustules grouped in oval clusters. This stage of the rust is seldom noticed by asparagus growers. The second or summer stage is the one that is usually first noticed and called by them the red rust on account of the elongated reddish-brown pustules which are seen breaking through the skin on the stem. The third stage of the disease is seen towards fall or whenever the vitality of the asparagus plants is reduced. It is known as the black rust or winter rust and is characterized by elongated black lines which replace the reddish brown pustules of the red rust stage.

Cause. The fungus which causes asparagus rust is Puccinia asparagi D.C. It produces four kinds of spores which take a direct part in its life history. In the elongated black lines of the black rust or winter rust thick-walled two-celled dark brown spores are produced. These are known as winter spores (teliospores). They pass the winter on the old asparagus tops and refuse. In the spring they germinate and each one may produce eight very minute spores which we may call spring spores (basidiospores). These are scattered by the wind about the time the young asparagus shoots are emerging from the ground. They infect these young shoots and give rise to the cluster-cup stage of rust. In each of the cup-shaped pustules on the young shoots are produced chains of thin-walled orange-colored spores known as cluster-cup spores. These cluster-cup spores are scattered by the wind and infect the stems of asparagus plants giving rise to the red rust or summer rust stage of the disease. In the elongated reddish-brown pustules of this stage are produced numerous thin-walled oval orange-colored spores known as red rust spores or summer spores (urediniospores). These serve to spread the rust during the growing season. Moisture is essential for the spread of the rust, heavy dews having more influence on its spread than rain.

Control. Grow varieties of asparagus which are known to be rust resistant. Martha Washington and Mary Washington are two commercial varieties which are resistant to rust. If a grower desires to secure a resistant variety of asparagus and is not sure where to obtain it, he should consult the agricultural representative in his county or the Department of Horticulture, Ontario Agricultural College. The various gardeners' journals print advertisements of reliable firms that sell desirable rust resistant strains of asparagus.

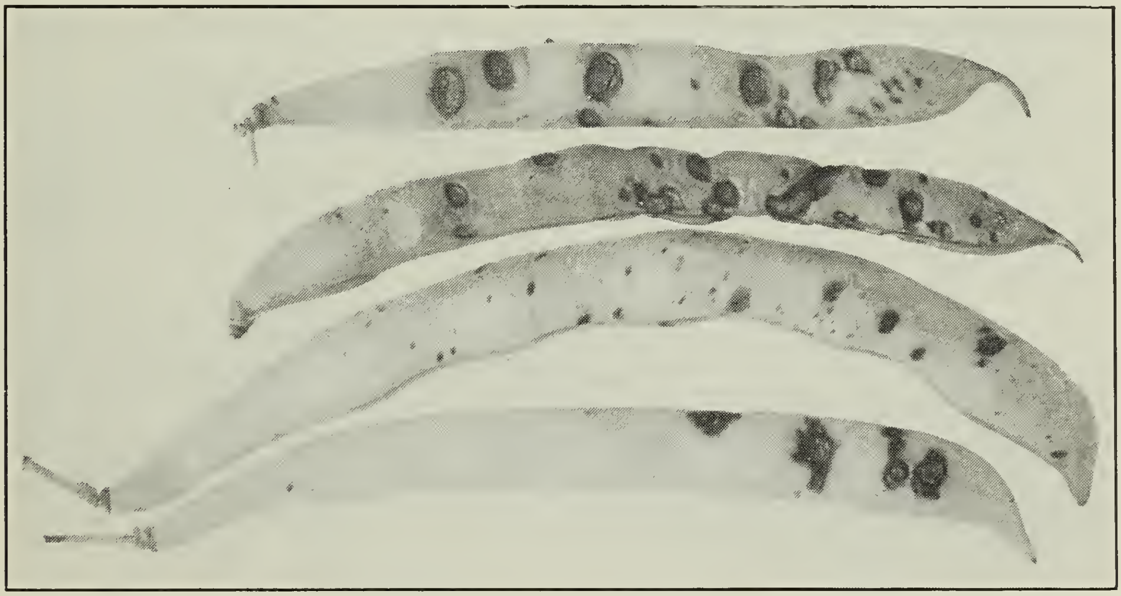
It is very difficult indeed to prevent rust from developing on varieties which are susceptible to it. Such varieties should be put as far away from all windbreaks as possible. The rows should be planted in the direction of prevailing winds and far enough apart to permit air to circulate freely among the branches so that the excessive moisture on the plants from dew and rain will dry up quickly. Do not let any plants, even wild ones, mature during the cutting season. Late in the fall when growth is over cut out and burn the old plants. Destroy any wild asparagus plants that may be growing in the neighbourhood of the asparagus bed. Spraying with Bordeaux mixture and dusting with sulphur have been tried and fair results obtained in the United States. Spraying or dusting however, is a difficult and costly undertaking and it is doubtful whether it would pay here in Ontario.

BEANS

ANTHRACNOSE OR POD SPOT. This is the commonest and most serious disease to which beans are subject. In wet seasons it causes great loss by destroying both garden and field beans.

Symptoms. Pods, seeds, leaves and stems are affected. On the pods sunken, reddish-brown or black spots, usually with rusty brown borders, are seen. In the centre of these spots pinkish masses may be noticed frequently. Affected seeds show dark brown or rusty discolored spots. These are often very minute. On the leaves the chief symptom is the brown and rusted appearance of the main veins underneath. Sometimes these appear as if cut or eaten out by the fungus. Occasionally small holes appear in the leaf, due to the destruction of the veins by the fungus. On the stems, rusty brown, elongated spots are sometimes seen. Occasionally these spots are so deep as to cause the stem of the leaf to break at this point.

Cause. This disease is caused by the fungus Colletotrichum lindemuthianum (Sacc. & Magn.) Bri. & Cav. This fungus passes the winter chiefly as dormant fungus threads (mycelium) in infected seed and possibly to some extent as spores on the seed. It is also known to winter over on diseased material left in the field and in beanstraw. This fungus however, does not live long in the soil when separated from its host. The seed can be infected only through the pod, that is the fungus threads (mycelium) penetrate through the tissues of the pod into the seed beneath so that pods that are spotted with anthracnose contain infected seed while those that are free from spots contain non-infected seed. When infected seed is sown in the spring the fungus threads inside become active and grow and the first crop of spores of the season is produced on the seed leaves (cotyledons) of the seedlings. From these they spread to the true leaves and stems and later to the developing pods. The spores of this fungus are held together on the surface of the affected parts by the gelatinous nature of the sporecoat and are only scattered when the beans are wet with rain or dew which dissolves the gelatinous substance by which the spores are glued to the surface of the pod.



Bean Anthracnose Pods, showing the spots characteristic of the disease. (*Courtesy of the Department of Plant Pathology, Cornell University*).

Control. Use non-infected seed. Such seed can be secured by selecting it from disease-free pods. This method is quite simple and satisfactory for small garden plots of beans and for a seed plot from which to secure a seed supply of field beans for the following year. In the fall of the year after the beans ripen gather enough disease-free pods to supply the seed necessary for the following season. Clean seed alone however, is not enough to insure a healthy crop. It must be planted far enough from infested fields so that spores will not be carried from the diseased plants to the healthy plants grown from the clean seed. If Anthracnose is bad, beans should not be planted on the same ground oftener than once in three or four years. Beanstraw should never be used for manure with the bean crop. Do not work among the beans when they are wet with rain or dew. Some varieties of beans are much more resistant to pod spot than others. These resistant varieties can often be used to advantage. Wells Red Kidney, White Imperial, Perry Marrow are varieties of dry beans which show a marked resistance to pod spot. There are also a number of varieties of wax and green pod, bush and pole beans which are more or less resistant. Burpee's stringless green pod has shown marked resistance in field trials here at Guelph for the past four years.

BACTERIOSIS OF BEANS—BEAN BLIGHT

(*Phytomonas phaseoli*) *Erw. F. Smith, S.A.B.*

This disease produces spots or patches on leaves, stems, pods and beans within the pods, somewhat similar in appearance to those caused by anthracnose. It may also produce a wilt when the vascular system of the plant is invaded by the bacteria.

Symptoms: *On Leaves.* The disease first appears as minute dark green, water-soaked spots around point of infection, which, under favourable conditions, increase in size to a quarter of an inch or so, and, if they are close together, they may join up and thus form large patches. If the plants are juicy a light amber coloured sticky fluid is liable to ooze out on to the surface of the diseased parts. This dries and forms a thin scale on the surface. The middle portion of the diseased areas dies and turns brown. The dead tissue becoming dry and brittle in the sun or soft in the rain, is liable to break away, thus leaving the foliage in a ragged condition, torn around the edges and full of holes. If the leaves are infected when they are young they are liable to be distorted.

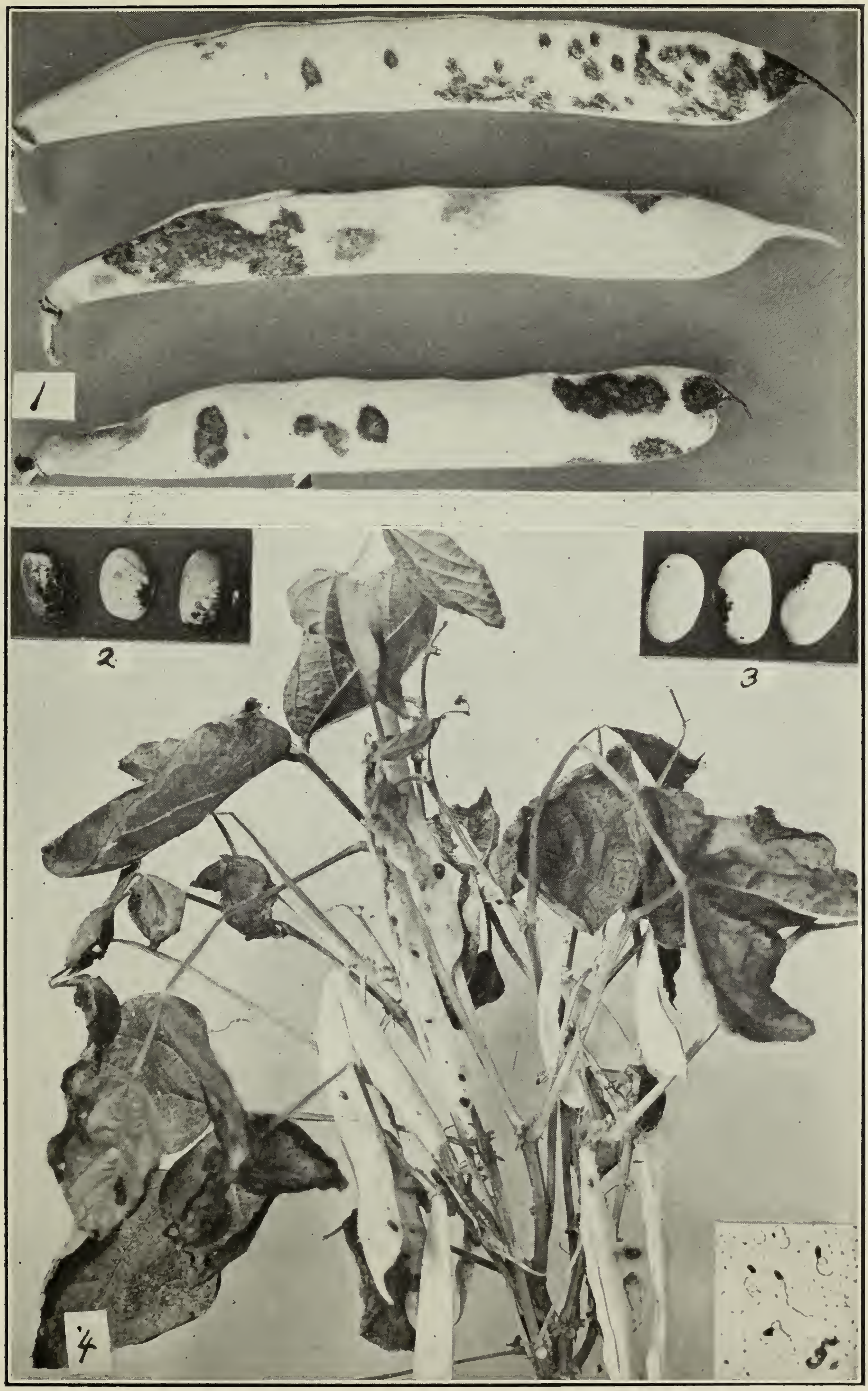
On Stems and Leaf Petioles. The disease appears first as water-soaked areas which later develop a brown cankered appearance extending up and down and often girdling the part. These areas later become dry and brittle so that the stems or petioles affected are easily broken at these points by wind or cultivator or other disturbing agent. Much defoliation is liable to occur in this way.

On Pods. The disease first shows as small water-soaked patches which, under favourable conditions, rapidly enlarge and develop a somewhat blister-like reddish brown, cankered appearance, not sunken in the middle as in case of anthracnose, but frequently slightly raised above the level of the surrounding healthy tissue, and more or less irregular in outline.

On Beans Within the Pod. The disease may develop as a result of the bacteria working in from diseased pods. If the bean seeds are thus infected when they are young, they do not mature but become more or less shrunken and discoloured brown. If the bean seeds are fully grown and nearing maturity before the bacteria reach the interior of the pods, they usually become smeared with the gummy exudate from the diseased pods which may dry on them like a coat of varnish. In this dried exudate the bacteria may remain alive for several years. Where such contaminated seed is sown it produces diseased plants that soon die.

On Cotyledons of seedlings grown from diseased or contaminated seed, brown or amber coloured canker-like patches are apt to develop from the renewed activities of the bacteria that have remained dormant over winter on the seed. From this infection of the cotyledons the bacteria readily gain entrance to the vascular system of the plant, clog it up, and so cause the plant to wilt and then die.

Cause. *Phytomonas phaseoli*, the species of bacteria that causes this disease is a short rod about one ten thousandth of an inch long. It gains entrance to the various parts of growing bean plants mostly through the stomates (breathing pores) and through injuries made by insects, cultivators, wind and other agencies. On gaining entrance to the plant it feeds on the plant juices, rapidly multiplies and spreads from its point of entrance into the surrounding tissues along the intercellular spaces, causing the discolouration and cankered condition above described.



Bacteriosis of Beans. (Original).

1. Diseased pods.
2. Diseased beans from diseased pods.
3. Healthy beans.
4. Bean plant badly affected with bacteriosis in foliage and pods.
5. *Ps. phaseoli*, the cause of the disease.

Control. Use for sowing only those seed beans known to be free from disease. Select healthy bean pods in the field from which to obtain disease-free seed.

Bean seed treatments with chemicals, hot water or dry heat are not effective in disinfecting the seed, and moreover they are apt to cause considerable direct injury to the seed.

Some authorities recommend the use of seed beans that have been stored for two or three years for giving blight free plants. The writer, however, has found the bacteria that cause the disease alive on beans taken from diseased pods that had been stored in a dry laboratory for four years.

Bean straw from crops where the disease has been present, should be carefully gathered and burned.

BEAN MOSAIC

This disease is frequently seen in Ontario. It sometimes causes very serious loss especially to pea beans. Certain strains of pea beans have had to be discarded on account of their susceptibility to this trouble. Wax beans and green pod bush beans are also subject to Mosaic.

Symptoms. Badly affected plants are stunted and sickly yellow in colour with the leaves puckered and mottled with an alternate light greenish-yellow and dark green patches. The diseased plants usually remain alive until the end of the season. Those which are infected early in the summer rarely bear any seed though they sometimes continue to blossom until autumn. Those that do not contract the disease until late in the summer develop pods which are apparently normal.

Cause. No organism has been discovered to account for this disease. It is one of the so-called virus diseases, that is, there is a something in the juice of diseased plants which, for want of a better name, is termed a virus, which if transferred to healthy plants will cause the disease. So far as is known the virus which causes this disease is carried over the winter only in the bean seed. Infected seeds produce mosaic plants. In other words seeds from diseased plants produce diseased plants. The virus is spread from diseased to healthy plants by various insects and may possibly be spread from plant to plant upon implements and by the hands of workmen as it is known that it may be transferred in any manner that juice may be transferred from one plant to another. Once inside the plant it may spread to all parts of the plant including the pods and the seed.

Control. The use of the more resistant varieties of beans is the most practical method of avoiding loss from Bean Mosaic. The Robust Pea Bean is said to be one of the most resistant varieties. *Other varieties of beans which are resistant in various degrees to Mosaic are: Red Marrow, White Marrow, Long Pod. Keeney Rustless, Germain Black Wax, Michigan White Wax, Refugee Wax, Prolific Black Wax, Scarlet Flagolet and Red Valentine.

*Manual of Vegetable Garden Diseases by Charles Chupp.

BEAN RUST

This is a common but seldom a serious disease in Ontario. It is seen on all kinds of beans, especially pea beans.

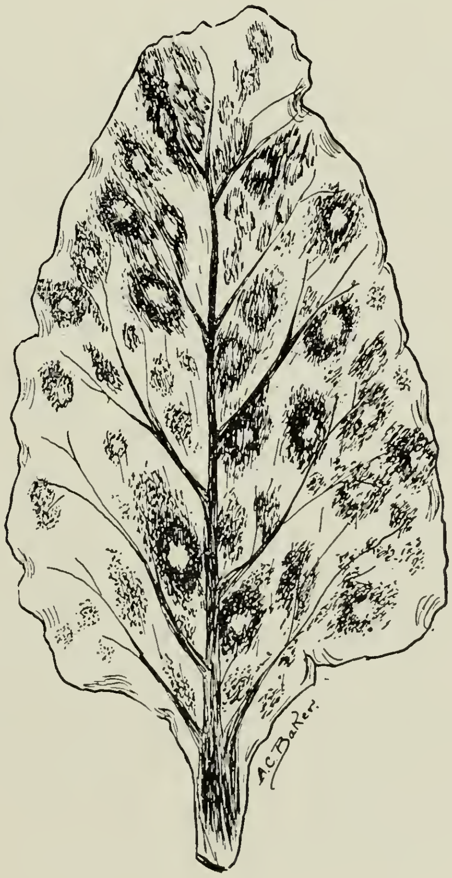
Symptoms. Rust spots appear on all parts of the plant above the ground. They are however, usually most numerous on the under side of the leaves. The rust spots are distinctly circular, slightly raised. At first they are reddish-brown in colour, later in the season they turn black. They may be very numerous on the under surface of the leaves.

Cause. The fungus which causes bean rust is Uromyces appendiculatus (Pers.) Lev. This fungus produces red rust spores (urediniospores) and black rust spores (teliospores) on the lower surface of the leaves and other affected parts of the plant. It is carried over the winter chiefly as the teliospores on the old leaves and stems.

Control. The easiest way of avoiding this disease is by using the more resistant varieties. Pole Beans are more susceptible to rust than are bush varieties. Green Pod strains are less resistant than are those with wax pods. Nothing has been done in Ontario in regard to the selection of resistant varieties as bean rust has never been a serious disease in this Province. Experimental work carried on in Virginia has supplied us with the following lists of more or less resistant varieties:

Resistant varieties of pole beans: Marblehead, Tennessee Wonder, Brockton, Indian Chief, Everbearing.

Resistant varieties of bush beans: Hodson Green Pod, Early Refugee, Mexican Red, Golden Eye, Detroit, Hodson Wax, Wells Red Kidney, White Kidney, Yellow Eye.



Leaf of beet attacked by leaf-spot fungus (*Cercospora beticola*).

BEETS

Leaf Spot. This disease is very common in Ontario but seldom causes serious injury to garden varieties. In some seasons it severely injures the leaves of sugar beets and mangels.

Symptoms. It is easily recognized by the small white or brown spots with purple margins which are scattered irregularly over the leaves. In the later stages of the disease these spots become ash-grey in colour. When they are very numerous the leaves wither and die. Sugar beets severely injured by this disease develop long crowns and are not desirable for sugar purposes.

Cause. This disease is caused by the fungus Cercospora beticola Sacc. The spores of this fungus are scattered by rain, insects, cultivating tools, workmen and wind. It passes the winter in the old infested refuse or on the seed. High humidity and temperature increase infection by this fungus.

Control. Plow under the old leaves deeply in the fall. Do not grow beets or closely related plants (Mangels and Swiss Chard) on the same ground oftener than once in two or three years. In small gardens rake up the diseased leaves and burn them or feed them to cattle. If the leaves of sugar beets or mangels are harvested and placed in the silo the fermentation will destroy the fungus. Spraying with Bordeaux every two weeks or ten days will control this disease but is seldom necessary.

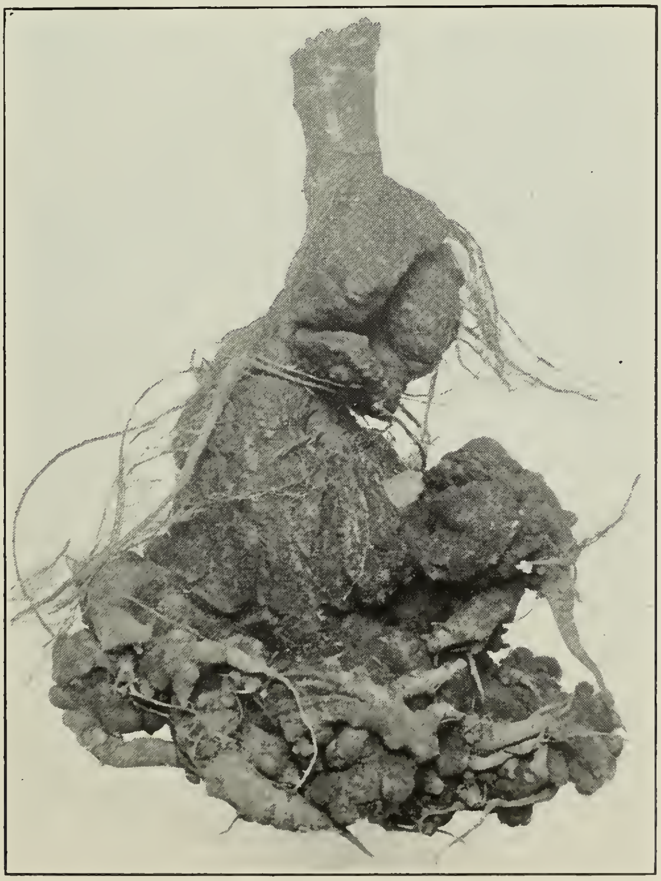
CABBAGES

CLUB ROOT. This is a disease of cabbage, cauliflower, turnips, radishes and other members of the Mustard family (Cruciferae). It is a very troublesome disease in the Maritime Provinces and is occasionally met with in Ontario especially in market gardens in the vicinities of our larger cities.

Symptoms. Affected plants are noticed to flag or wilt markedly and if their roots are examined irregular thickenings and knob-like swellings are found upon them. These often reach the size of a man's fist. The tops of diseased plants develop very slowly. Affected cabbage and cauliflower plants form little or no head. Sometimes the plants are completely killed. Late in the season the diseased roots may rot.

Cause. This disease is caused by a slime fungus known as Plasmodiophora brassicae Wor. This is a soil organism that may remain in the soil for several years. It is spread in seedling plants, in contaminated manure, on farm implements and on the feet of man and animals. It may be washed from high to low land by running water. Experiments have shown that this parasite does not thrive in soil which is highly alkali and that it does most damage in poorly drained acid soil. It is stated that the spores germinate and infection takes place readily only when the soil is warm and wet.

Control. The location of the seed bed is important. It should be so situated that it is not subject to being washed by water running down from higher ground above it. The position of the seed bed should be changed from time to time or the soil in it renewed or sterilized with live steam. Seedlings should be carefully inspected for any evidence of Club Root. If any infected seedlings are discovered the whole lot should be discarded as many of them will probably develop the disease after they are planted out. Corrosive sublimate has been found to be of considerable value in preventing the development of Club Root in seed beds in which the soil is infested. One ounce to 10 gallons of water is recommended for the prevention of Club Root in young cabbage plants. The first application should be made as soon as the plants are through the soil. Four or five additional applications should be given at weekly intervals. Cauliflower plants are injured by such a strong solution of Corrosive sublimate but may be safely treated with 1 ounce of corrosive sublimate in 15 gallons of water. Good results have also been obtained by disinfecting the soil in seed beds with Uspulun. Care must be taken not to use contaminated manure. It is often wise to substitute commercial fertilizers for farmyard manure, especially in the seed bed. Fields should be kept as free as possible from weeds belonging to the Mustard family as they may harbor the disease. If a few diseased plants are found in the field they should be pulled and burned at once. If the soil becomes infested a rotation of crops should be practised. Plants belonging to the Mustard family should not be grown in such soils oftener than once in six or eight years. If it is impossible to follow a long rotation of crops and cabbages, cauliflowers or turnips must be planted on infested soil, a very liberal application of lime applied three to six months before planting is recommended. The amount of lime required will vary with different soils depending upon their acidity. From two to five tons per acre should be worked thoroughly into the soil. Such large quantities of lime are often undesirable especially if potatoes are in the rotation and should not be used if it is possible to grow cabbages, cauliflowers and turnips on disease-free soil. All refuse from a diseased crop should be burned. If it is necessary to feed diseased turnips or other roots they should be thoroughly boiled.



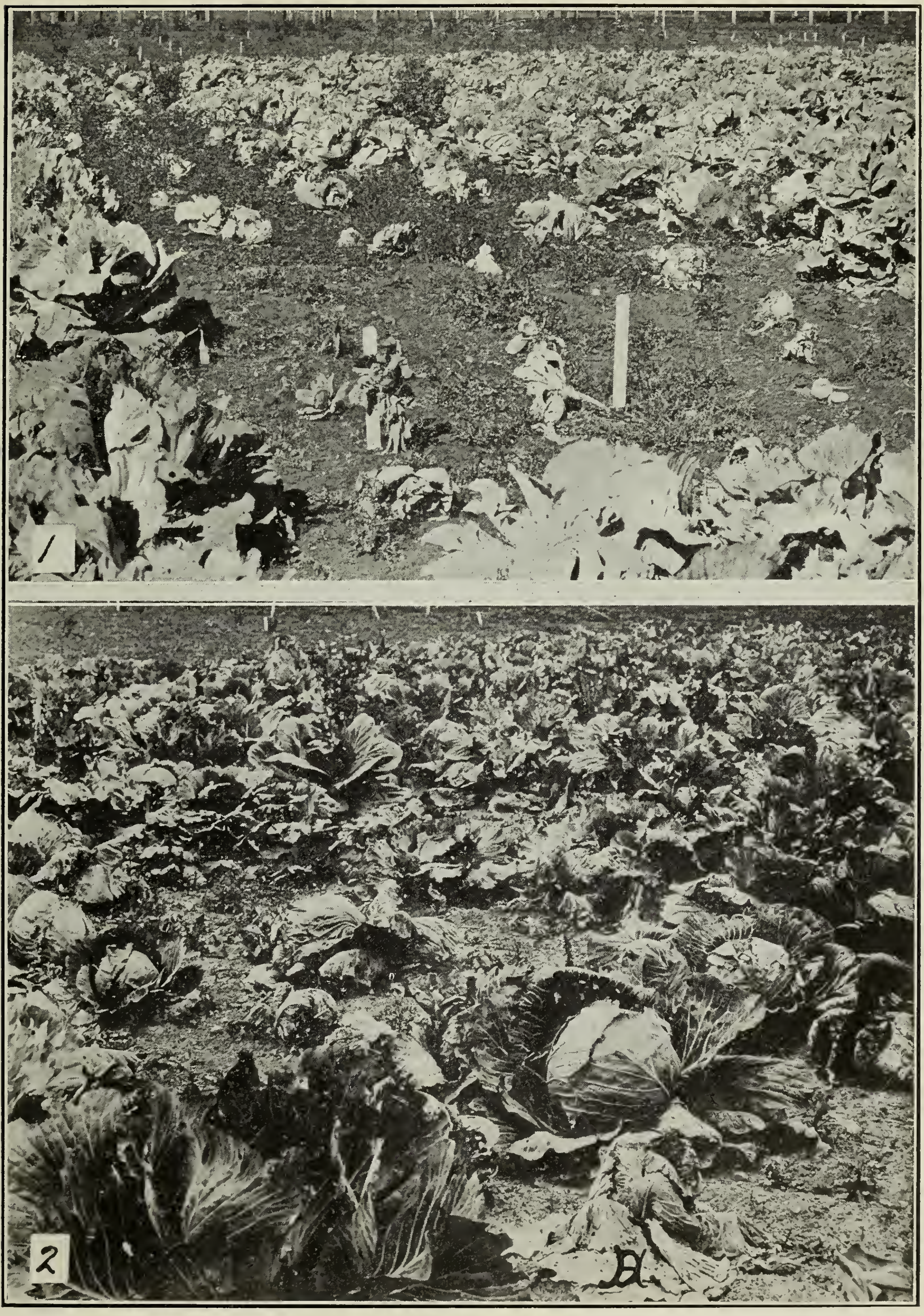
Club Root of Cabbage. (Original.)

BLACKLEG OF CABBAGE. This disease is not confined to cabbages but is seen also on cauliflowers, Brussels Sprouts, Swede turnips, Kohl rabi, kale, rape, radish and several other cultivated plants belonging to the mustard family. In this Province cabbage and cauliflower are the only crops which are severely affected by this disease.

Symptoms. Plants may show the disease in the seed bed or in the field. Near the base of the stem are seen oval, depressed, light brown cankers. These enlarge and girdle the stem. The affected tissues turn black and the stem and roots decay. The blackening of the base of the stem has lead to this disease being called Blackleg. Light brown spots may also appear on the leaves. In the cankers on the stem and in the spots on the leaves, numerous black dots, (the fruiting bodies of the fungus) may be seen. Badly diseased plants may wilt. Sometimes the edges of the leaves turn bluish red in colour. If the stems and roots of the older plants decay the weight of the heads causes them to lean or fall over. Affected plants usually die in a comparatively short time but in damp soil they may live over for a long time and even form heads.

Cause. Phoma lingam (Tode) Desm. is the fungus responsible for this disease. It passes the winter as fungus threads (mycelium) in the seed and as spores and fungus threads on the seed, and with the cabbage refuse in the soil. This fungus remains alive in the soil as long as any particles of cabbage or cauliflower stalks are left intact. It is disseminated in soil or manure containing cabbage refuse. Spring freshets carry the spores over large areas of a field or from one field to another. It is also spread on cultivating tools and by insects. The fungus appears to require abundance of moisture before it will develop rapidly, as the severity of the disease appears to be in direct proportion to the amount of rainfall in the early summer.

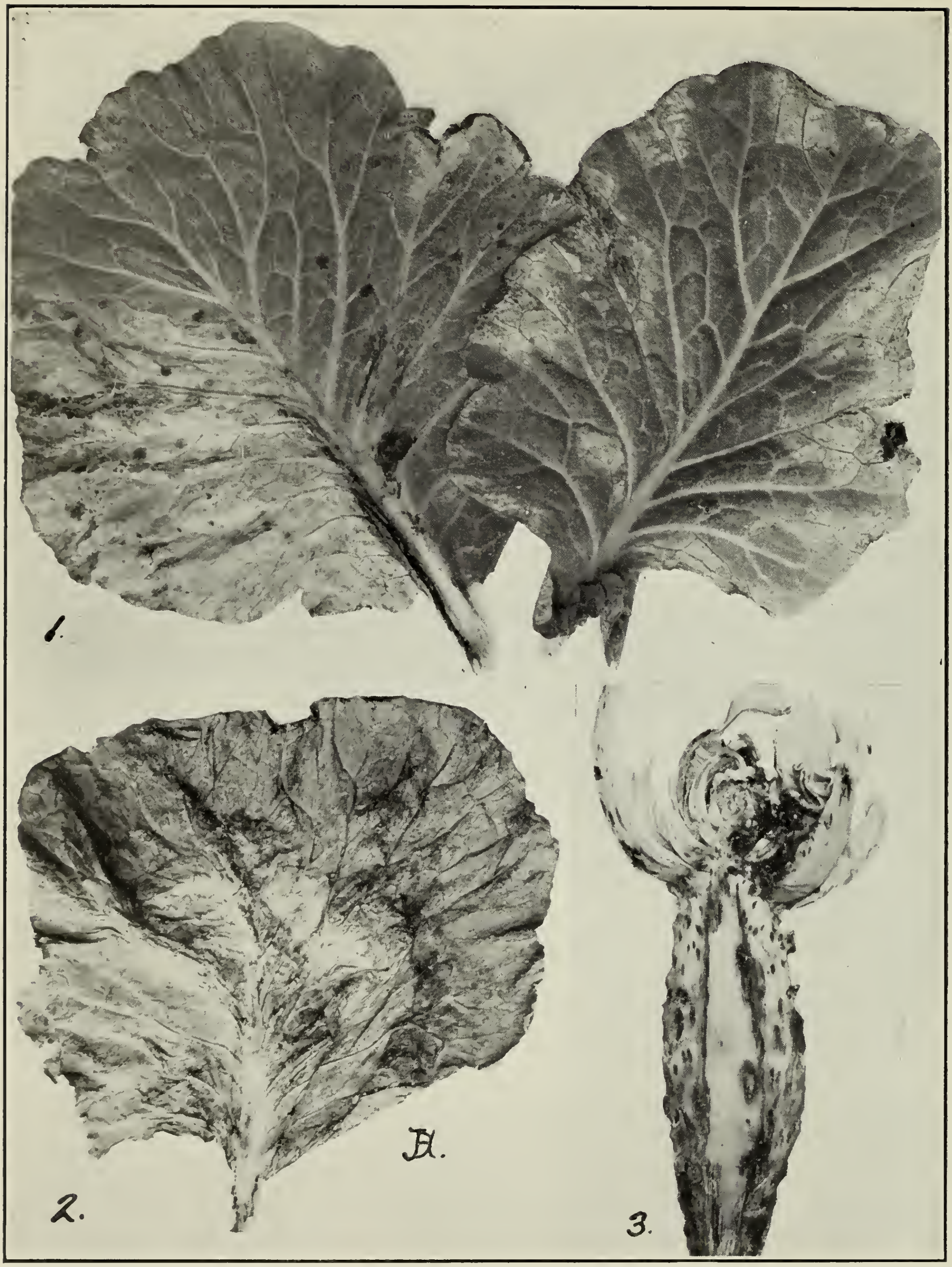
Control. Arrange a rotation of crops in which cabbage, cauliflower and other plants belonging to the mustard family are not grown on the same soil oftener than once in every four years. Rake up and burn the refuse from the diseased crop. Do not use seedlings from a seed bed in which there is any indication of Blackleg. Use non-infected seed. Such seed can now be secured from the Puget Sound section of United States where the disease does not normally occur. If the source of the seed is unknown it is advisable to treat it with corrosive sublimate or hot water. The directions for treating the seed with corrosive sublimate are as follows:—Use a solution of corrosive sublimate of the strength of 1-1000 by weight, which is prepared by dissolving one tablet in a pint of water, or an ounce of corrosive sublimate powder in 6 gallons of water. Place the seed in a cheesecloth bag. Do not fill the bag more than half full. Then immerse it in the solution for twenty to thirty minutes. After this rinse the seed thoroughly in clean water then spread it out to dry. Corrosive sublimate is a comparatively handy seed disinfectant but does not give as complete control as does hot water. This is due to the fact that while it will kill all the fungus which adheres to the outside of the cabbage seed, it can not kill the fungus threads (mycelium) within the seed. Seed may be disinfected by immersing the bags in water heated to a temperature of 122°F. for 30 minutes. When the bags are immersed in the water it should be kept stirred constantly and the temperature maintained at 122°F. by adding from time to time small amounts of boiling water. After the bags are removed from the hot water they should be dipped in cool water, after which the seed should be spread out to dry. This treatment is very effective but reduces the germination of the seed to a very considerable extent.



Bacterial Wilt of Crucifereae (Black Rot of Cabbage). (Original).
1 and 2. Views in a cabbage plantation, showing numerous cases of the disease in all stages of development.

BACTERIAL WILT (BLACK ROT) OF CABBAGE AND CAULIFLOWER
(*Phytomonas campestris*) *Pammel, S.A.B.*

This disease is found attacking many cultivated cruciferous plants, including cabbage, cauliflower, kohl-rabi, Brussels sprouts, broccoli, turnips, rape, kale and radish.



Bacterial Wilt of Crucifereae (Black Rot of Cabbage). (Original).

1. Cabbage leaves affected with the bacterial wilt or black rot. The lighter-shaded areas around the outer edge of the leaves are the diseased parts showing natural inoculation through the water pores on the edge of the leaves; the light-shaded areas were yellow.
2. The lighter shade part of the leaf near the base indicates the disease, and the blackened vascular bundles of the stem, where it is cut, indicates that the disease entered this leaf from the main stalk of the cabbage.
3. Cabbage stalk and stunted head; the blackened vascular bundles indicate that the disease was general throughout the plant. The leaf of Fig. 2 was taken from this plant.

Symptoms. In the leaves of growing cabbage or cauliflower plants, the disease most commonly appears as browned or yellowed triangular or irregular shaped, somewhat transparent patches working in from the outer edge. Inside these discoloured areas the veins or vascular bundles will appear as a blackened network. When the disease is far advanced in the leaf, a black discolouration of the vascular bundles in the midrib can be noticed, even through the thick white flesh that surrounds them. If such a midrib be cross-sectioned the infected vascular bundles will show as dark brown or black spots, and if a longitudinal section be made they will appear as dark brown or black streaks instead of white or pale yellow, as they should be if healthy.

Stems. When a leaf presenting the above symptoms is broken from the stem the vascular bundles showing on the leaf scar of the stem will appear as blackened dots, and if with the aid of a knife these infected vascular bundles be followed into the stem, the black discolouration may be found there in the bundles running up and down the stem. In advanced cases the surrounding tissue breaks down and cavities are produced.

Young Plants. If a plant contracts the disease as a seedling, or soon after being planted out, the chances are that it will either die soon or become a stunted, shrivelled, wilted specimen, producing no head, in the case of cabbage or cauliflower, and no bottom in the case of turnip.

Cause. The bacteria that cause this disease get established in the leaf veins and vessels of the vascular bundles where they multiply and clog up the passages, thus preventing the transmission of moisture and causing wilt.

One of the most common ways by which they gain entrance to the vascular system is through the water pores around the edges of the leaves. In the early morning, particularly in moist, cloudy weather, little dew-like droplets of water may be seen at the water pores around the edges of cabbage leaves and leaves of allied plants. This is water of transpiration which has not evaporated on account of the humidity of the atmosphere. Should the bacteria that cause this disease be around the edges of the leaves, having got there from contaminated soil or been deposited there by insects, slugs, caterpillars or other agencies, they will find conditions satisfactory for entering the waterpores, from which they invade the fine network of veins and slowly make their way through these channels until they reach the vascular bundles of the midrib, and later the stalk. Such progress may take several weeks. In moist weather development is much more rapid than in dry weather.

If the plants are well on towards maturity before such leaf infection takes place, losses will not be severe. The earlier the infection takes place the greater the damage to the plant.

Control. Should the disease be noticed among seedlings in the seed bed the diseased plants should be removed and burned. If they are not burned the bacteria within them are liable in many ways to get transferred to the healthy stock, and so the disease be spread instead of being checked.

Seedlings that show signs of the disease should not be planted out. It is not usually of much use simply to break a diseased leaf from what appears to be an otherwise healthy plant. If the disease is confined to the marginal areas of the leaf, entirely, then breaking off the leaf would prevent the rest of the plant from developing the disease. But should the vascular bundles in the midrib of the leaf at the point of its contact with the plant stalk, be discoloured brown or black we may take it for granted that the bacteria are already established in the vascular bundles of the stalk, in which case the whole plant should be destroyed.

Cabbage heads which on harvesting show blackened vascular bundles in the stalk close up to the head, should not be stored away but sold for immediate consumption. If such heads are stored away, the bacteria are liable to pass from the stalk to the vascular system of the leaves composing the head, and cause slow death to the tissues which then rot during storage.

Seed beds are often contaminated with the bacteria that cause this disease by having thrown onto them compost or manure on which diseased plants have been deposited to rot. While it is very doubtful that the bacteria enter the plant through the root hairs, any injury to the root or leaves that are near the ground may result in the establishment of the disease in the plant. Caterpillars and slugs crawling over such soil would be very liable to inoculate the plants growing there by crawling over and feeding on them.

Disinfecting Seed. Place seed in a cotton bag and suspend it for fifteen minutes in a solution of corrosive sublimate one part to one thousand parts of water; or in a formaldehyde solution of one part formalin (40 per cent. formaldehyde) to two hundred and forty parts of water. After treatment the seed should be dried without delay.

BACTERIAL SOFT ROT OF CABBAGE AND CAULIFLOWER

(See Bacterial Soft Rot of Vegetables)

CELERY

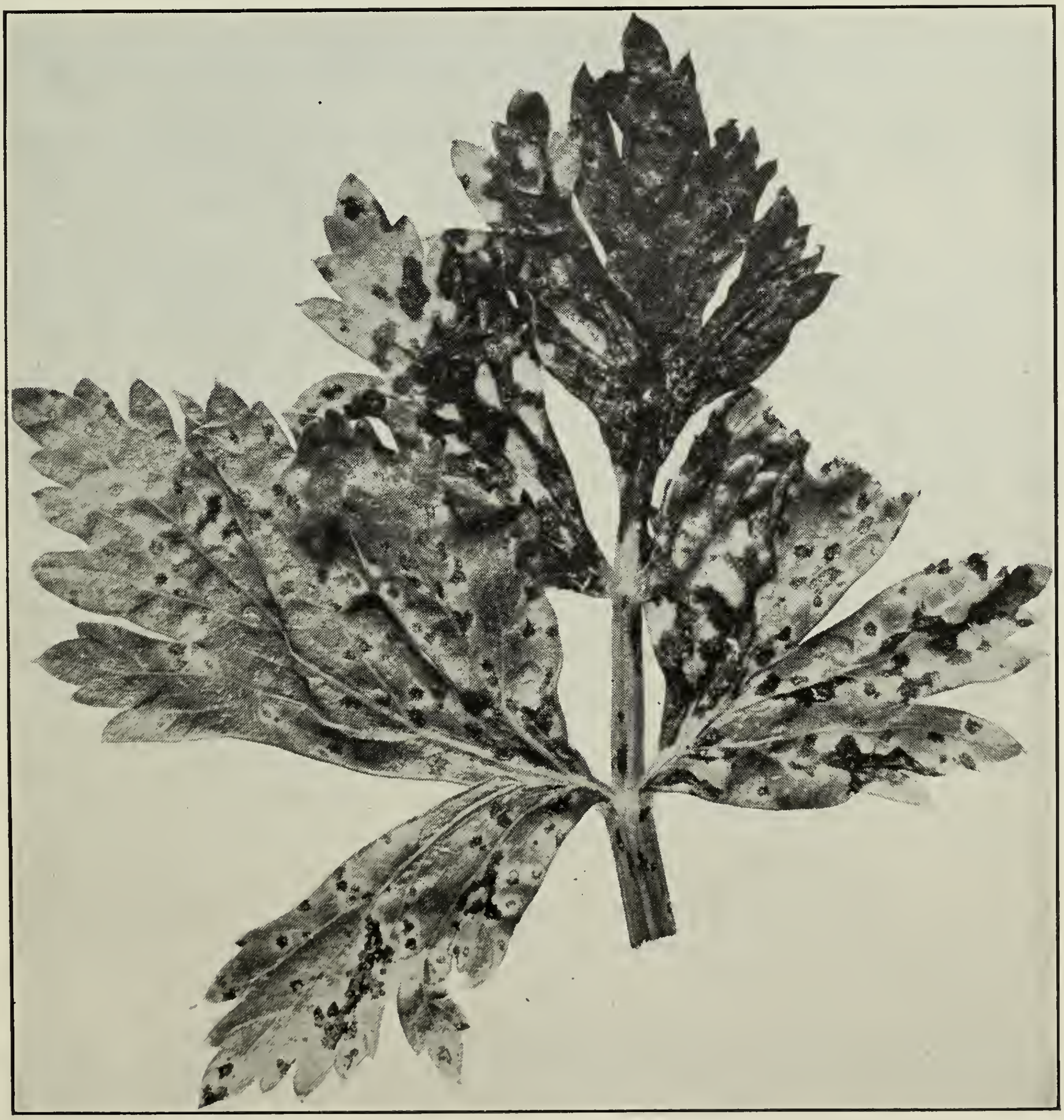
LATE BLIGHT OR SEPTORIA LEAF SPOT. This is the most common and destructive celery disease in Ontario. In wet seasons it is very severe and ruins large quantities of celery. It is not usually noticed by the grower until late in the season but a careful observer usually can find a little of it in the seed bed or in the field shortly after the plants are set out.

Symptoms. On infected leaves irregular brownish spots usually develop. In these may be seen numerous minute black specks, the fruiting bodies of the fungus, (pycnidia). When the disease is very bad however, on many of the leaves the characteristic spots may not develop but the whole leaf may be affected at once, become covered with minute black specks, dry and wither up. The lower leaves are almost always the first to show symptoms of the disease. The stems also are affected. On these are seen irregular rusty brown, somewhat water-soaked areas with the characteristic minute black specks. These rusty brown spots on the stems are often spoken of as rust by celery growers but are not true celery rust, but simply a manifestation of Late Blight on the stems. In storage diseased stalks decay due to secondary fungi and bacteria which follow the Blight fungus.

Cause. The causal fungus is Septoria apii (Br. & Cav.) Rostrup. This fungus produces numerous spores in the little black specks (pycnidia) embedded *in the skin* of the diseased leaves. When the plants are wet with rain or heavy dew these spores are discharged and spread by means of water, wind, insects, implements, men and horses. The fungus lives over winter in the diseased leaves and stems left lying on the field and in the seed-beds.

Control. Spraying with Bordeaux or dusting with copper-lime dust is the most reliable means of preventing this disease. The liquid Bordeaux has given the best results in our experiments here at the College but some growers secure satisfactory results with copper-lime dust applied frequently with high pressure.

The directions for spraying celery with Bordeaux are as follows: Give two applications when the plants are still in the seed bed using Bordeaux mixture of the strength of 3 pounds of bluestone and 6 pounds of hydrated lime to 40 gallons of water. The first application should be made when the plants are from two to three inches high and the second application given a short time before setting the plants out in the field. The field spraying should be started a week or ten days after the plants are set out. For the field applications use Bordeaux mixture of the strength of 4 pounds of copper sulphate, 8 pounds of hydrated lime and 40 gallons of water. Applications should be made at an interval of a week or ten days during the season. The wetter the weather the greater the number of applications that will be required. When the plants are small 40 gallons of the spray mixture will be sufficient for an acre but when the plants are



Late Blight of Celery.
(*Courtesy of the Department of Plant Pathology, Cornell University*).

large it will require two or three times this much. It is very important that the Bordeaux should be applied under high pressure. The sprayer should be rigged with three nozzles to each row, one from the top and one from each side. Late Blight spreads most rapidly during wet weather. It is therefore important to see that the Bordeaux is on the plants before rain comes rather than after.

The directions for dusting celery are as follows: Use 20 per cent. Copper-lime dust. Give two applications as described above while the plants are still in the seed bed and repeat at intervals of from 3 to 10 days after the plants are set out in the field. In very wet weather it may be necessary to apply the dust as often as twice a week. The best results from dusting are secured by using liberal quantities of dust and applying it under high pressure.

Other precautions which should be taken: Rake up and burn the diseased leaves and stalks. Plant celery so far as is possible on well drained land. Do not cultivate celery when the plants are wet and in cultivating take care not to get the soil into the crowns of the young plants. Rotation of crops is an effective means of preventing this disease as the causal organism is chiefly carried from year to year in the crop refuse in the soil, but it is not always practical under ordinary celery growing conditions. It is not advisable to attempt to store for any length of time celery affected with late blight. Before such celery is placed in storage the blighted leaves and stems should be stripped off. Those who grow large quantities of celery depend chiefly on spraying or dusting for the prevention of this disease.

EARLY BLIGHT OR CERCOSPORA LEAF BLIGHT. This disease compared with Late Blight of celery is of comparatively little importance in Ontario. It is seen to some extent every year and occasionally in isolated fields here and there it does considerable damage.

Symptoms. The name "Early Blight" is misleading as this disease does not usually appear until later in the season than the so-called "Late Blight." Usually it does not appear until the plants are from 6 to 8 weeks old while Late Blight is often seen shortly after the seedlings come above the ground. Affected leaves are characterized by more or less circular spots grayish green in colour at first, then becoming brown and later ashy. Separate spots generally have well marked borders. When numerous they run into each other in irregular patches.

Cause. Cercospora apii Fres. is the fungus which causes this disease. This fungus produces numerous spores on the surface of the leaves when the weather is hot and wet after a period of drouth. These spores are spread from plant to plant by rain, wind and during cultivation. The fungus is carried over the winter as hardened masses of mycelium (sclerotial growths) in the tissues of the diseased leaves.

Control. The recommendations given for the control of Late Blight of Celery apply in all their details to Early Blight.

CELERY YELLOWS. This disease was reported as occurring in Ontario for the first time in 1924. In the United States celery yellows has caused serious loss to celery growers especially in the State of Michigan. It is recorded as being most serious on certain strains of golden self blanching celery. These are said to be more susceptible than white plume and other winter varieties.

Symptoms. These are very distinct. Affected plants are stunted with yellow or yellowish-white leaves. They usually die prematurely. The veins (vascular bundles) of the roots and heart are reddish-brown in colour.

Cause. This disease is caused by a species of Fusarium. This fungus is a soil organism being carried over in the soil from year to year. Land badly infested with it is said to be worthless for the growing of many of the finer strains of golden self blanching celery. On account of the serious losses which may be caused by this disease Ontario celery growers should be on the watch for it.

Control. In Michigan it has been found that this disease can be avoided by growing resistant strains of golden self blanching celery. Such strains have been developed in Michigan and if Ontario celery growing soils become infected with the fungus which causes yellows, it may be necessary to introduce these resistant strains into this Province, or to develop here in the Province other resistant strains.

BACTERIAL SPOT DISEASE OF CELERY

(*Phytomonas apii*) *Jagger, S.A.B.*

This disease occurs on all varieties of celery commonly grown.

Symptoms. It appears as rusty brown spots, irregularly circular in outline, that rarely exceed a quarter of an inch in diameter. The spots closely resemble those caused by the celery late blight fungus. The latter however can be distinguished from the bacterial disease by the presence of the minute black pycnidia of the fungus fruiting bodies.

Occasionally the spots are so numerous as to cause the death of many of the older leaves, but usually the injury consists in the disfiguring of the foliage and in a possible reduction in growth of the plants. The disease seems to be confined to the leaf blades, spots seldom, if ever, occurring on the stalks.

The *Causal Organism* gains entrance either through the stomates or by means of insect puncture.

Spraying with Bordeaux mixture is effective in controlling this disease.

BACTERIAL SOFT ROT OF CELERY

(*See Bacterial Soft Rot of Vegetables*)

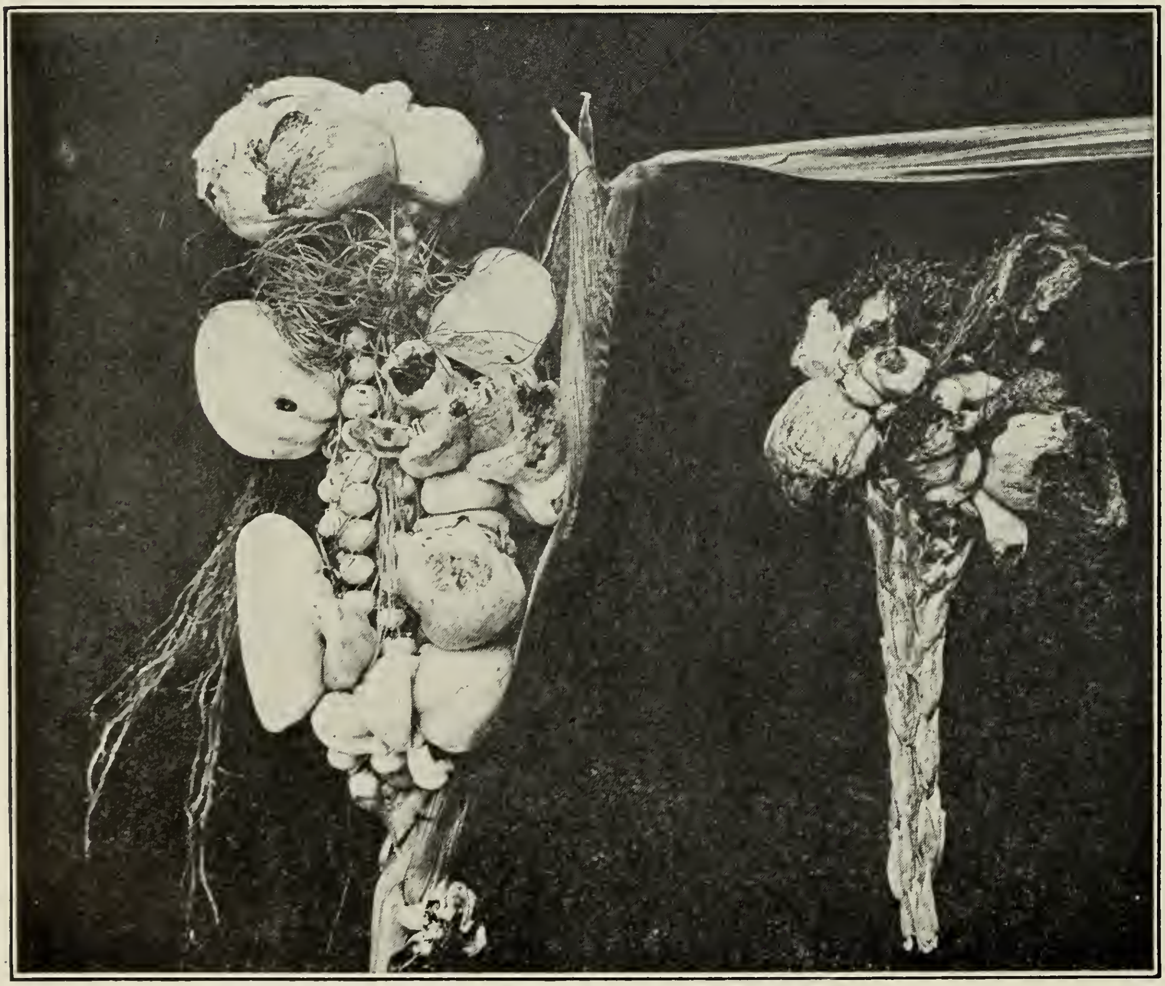
CORN

CORN SMUT. This smut is very frequently seen in Ontario and nearly everyone who grows any corn is familiar with it. The sugar or table corns seem to be especially susceptible to it.

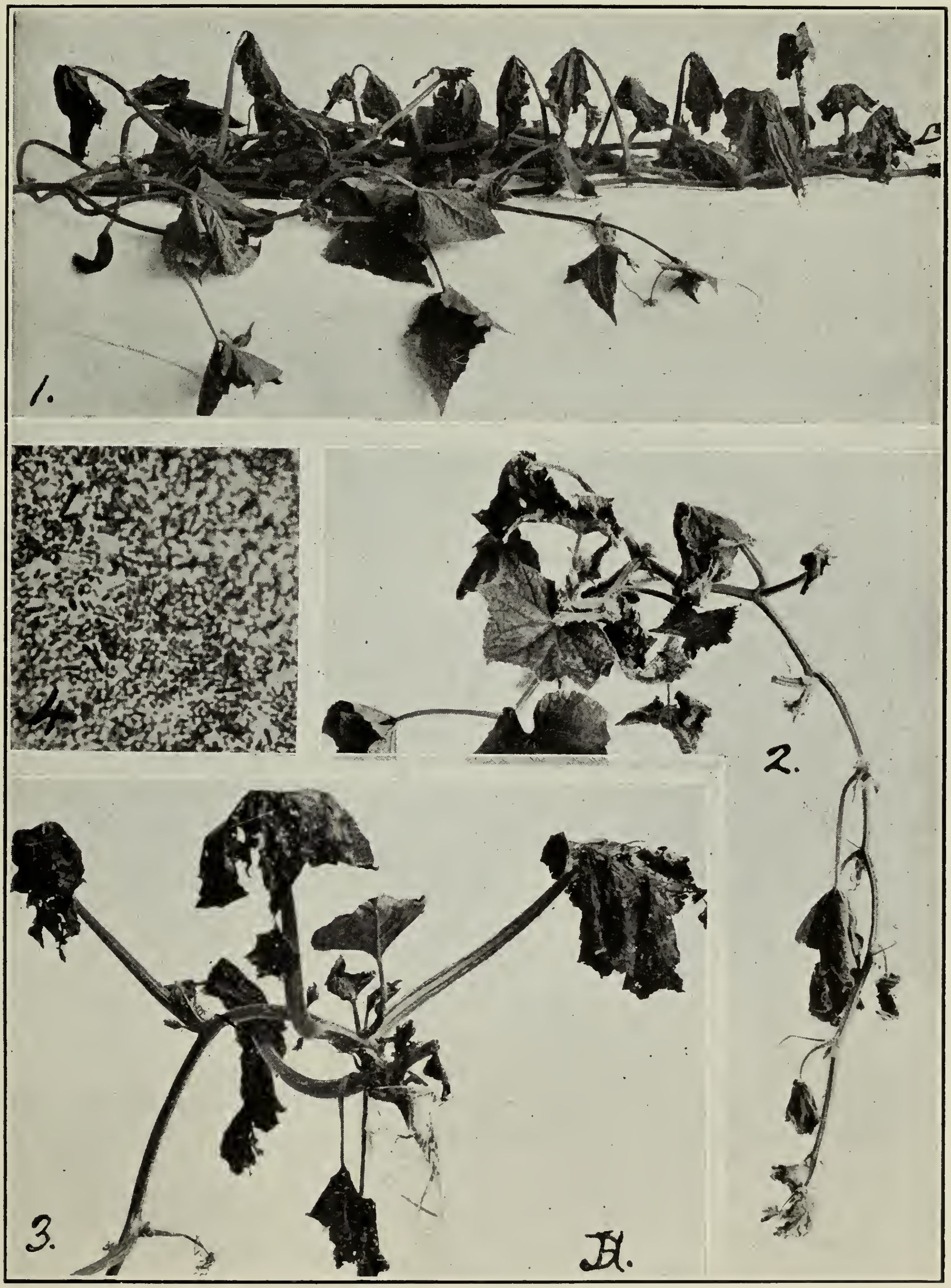
Symptoms. Corn smut attacks the ears, stalks, leaves and tassels. It produces on the parts affected peculiar growths frequently spoken of as "boils." These "boils" are sometimes six inches or more in diameter. In the early stages they are green, later white and polished and finally they become dark colored and rupture, exposing a brownish black mass of powder consisting of millions of spores. Corn smut usually appears on the plants when they are about three feet high but on very susceptible varieties like Golden Bantam it is sometimes seen when the plants are less than a foot high.

Cause. The fungus which causes corn smut is Ustilago zeae, (Beckman) Unger. As soon as the "boils" mature and rupture, the spores are scattered by the wind and other agencies. In the soil or in manure they germinate and produce great numbers of secondary spores which may infect any of the tender growing tissues of the corn plants. Thus the smut is spread during the growing season. The fungus is carried over the winter as spores in the soil and in manure. These may be contaminated in various ways. The spores may be scattered by the wind or the spore mass may be left in the field, or thrown on the refuse or manure pile. It is believed that the spores of this fungus may not only live in the manure pile but that they may actually grow and increase in number in warm fermenting manure.

Control. Treating the seed with a seed disinfectant such as formalin or bluestone will not prevent Corn Smut as the fungus which causes it is carried over the winter as spores in the soil and in manure. Go through the field and burn all smut growths as soon as they appear as each "boil" when mature is a source of infection to the healthy plants around it. This of course is only practical when small areas of corn are grown. Avoid fresh manure with the corn crop as it is very likely to contain live smut spores. If possible practise a rotation of crops. The spores of this fungus will not live for many years in the soil and those which are in the soil cannot injure any other garden crop. After three or four years corn may be planted again with less danger as many of the spores will have lost their vitality by this time.



Corn Smut on Ear and Tassel. **(About one-half natural size).**



Bacterial Wilt of Cucurbits. (Original).

1. Bacterial wilt of cucumber.
2. Bacterial wilt of cucumber.
3. Bacterial wilt of squash.
4. Stained microscope preparation from the viscous slimy exudate of a vascular bundle of a wilting cucumber plant, showing the bacteria (*Erw. trachiphila*), (× 1000 di).

CUCUMBERS

Bacterial Wilt of Cucumbers

(*Erwinia trachiphila*) *Erw. F. Smith.*

This wilt often causes serious losses to the growers of cucumbers, squashes, melons and other cucurbits. Whole fields or greenhouses of these plants are sometimes completely destroyed by the disease in a very short time,—one to three weeks.

Symptoms. The leaves and stems of plants suffering from this disease lose their turgidity and hang over limp and lifeless, thus presenting a badly wilted condition. They also lose their bright green colour and turn to a dull, dirty yellowish green. The fruit, when infected, becomes soft and appears somewhat water-soaked, and if squeezed will readily yield to pressure and often under such treatment the skin will rupture and a clear slimy liquid will ooze out. The flesh of diseased fruit is transparent and water-soaked in appearance. If a diseased stem be cut through, a gummy, slimy exudate will ooze out from the cut ends of the vascular bundles exposed on the cut surface. This slimy exudate will string out in strands when the cut surface is scraped with a knife or rubbed with the finger. This sliminess of the juice issuing from the vascular bundles is one of the most characteristic features of the disease, for a plant may wilt for lack of moisture and present an appearance something like a diseased plant. But if such a plant be cut and its juice expressed, this juice will be quite watery in consistency and not string out in slimy threads like the exudate from a diseased plant.

Cause. The bacteria that cause this disease are found almost entirely in the veins and vascular bundles of the diseased plant. Here they feed on the plant juice, grow and multiply, and choke up the vessels so that the passage of moisture from the roots to the leaves is interfered with, and thus the wilt develops.

The bacteria are carried from diseased plants to healthy plants almost entirely by the striped cucumber beetle, which after feeding on a diseased plant has its mouth parts covered with the bacteria, and these it carries to healthy plants which it subsequently feeds on.

Control. All diseased plants should be carefully removed and immediately burned. If they are allowed to lie around cucumber beetles and other insects will swarm about them, get themselves contaminated with the bacteria and spread the disease wherever they go.

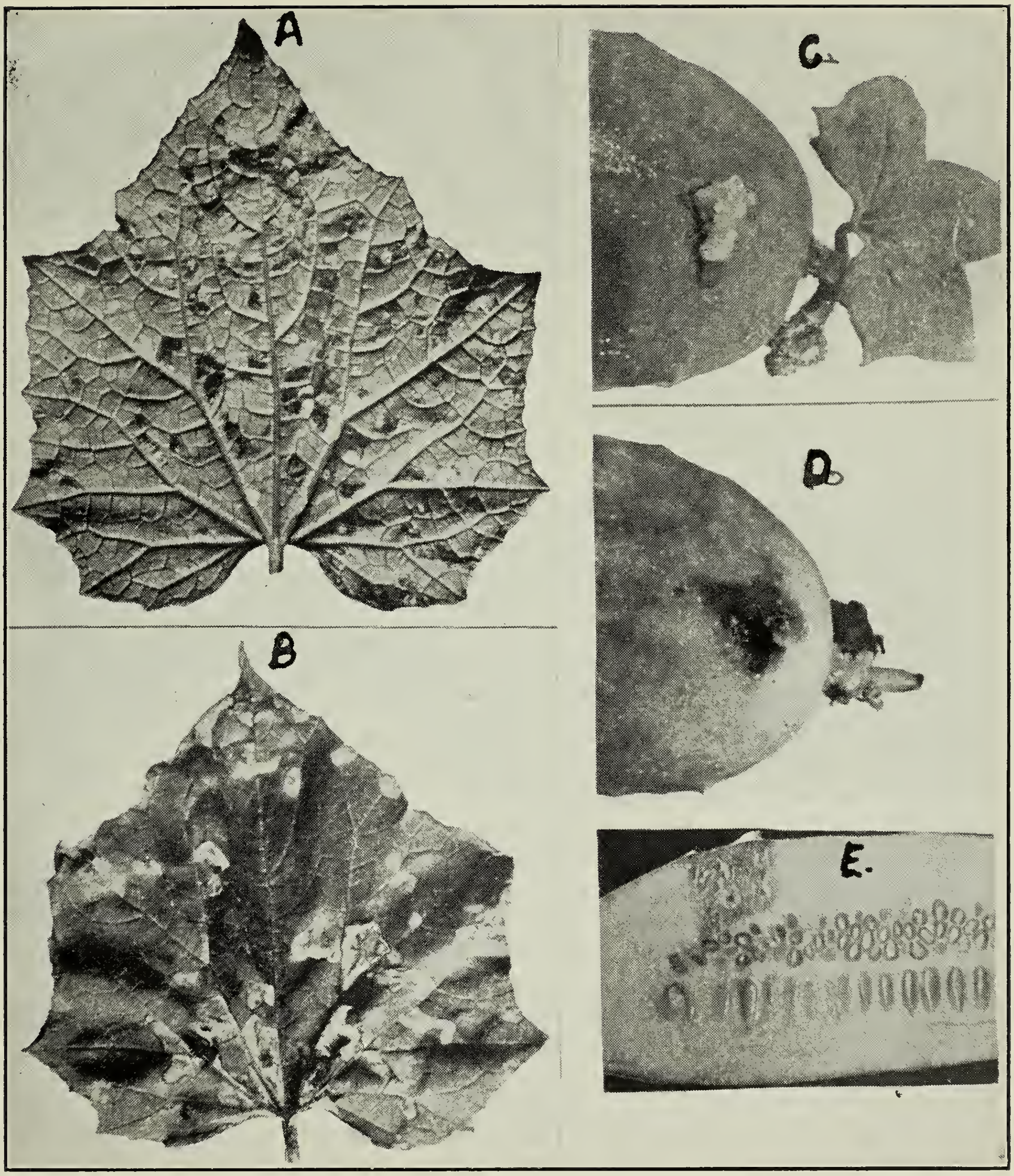
Biting insects, particularly the striped cucumber beetle, should be kept under control by spraying and hand picking.

Angular Leaf Spot of Cucumbers

(*Phytomonas lachrymans*), *Smith and Bryan, S.A.B.*

While this disease has not, so far, caused heavy losses in Ontario, it occasionally gives trouble to cucumber growers.

Symptoms. Angular spots are developed on the leaves. At first the spots present a water-soaked appearance, then they become brown and dry and often drop out, giving the leaves a ragged appearance. Frequently the spots become confluent, thus resulting in large irregular holes. In the early stages of spot development a bacterial exudate is liable to collect in glistening tear-like drops on the lower surface of the leaves, during the night, which later dries whitish.



A—Cucumber leaf eight days after inoculation with *Phytomonas lachrymans*. The bacterial exudate has dried down into white crusts.
B—Cucumber leaf twelve days after spraying with *Phytomonas lachrymans*. Diseased tissue shrivelled and spots falling out.
C—Green cucumber fruit photographed six days after inoculation with *Phytomonas lachrymans*. There is an exudate at the point inoculated while the remainder of the fruit is sound.
D.—Same as C. after twelve days; fruit ripening but still sound except at point of inoculation.
E—Section of green cucumber fruit ten days after inoculation. Tissue decayed only in vicinity of inoculation.

(After M. C. Bryan)

Young stems and leaf petioles may be infected. They become softened in the infected area and crack open or bend over. Little drops of bacterial exudate are liable to appear on these diseased parts.

Fruit may also be infected, but unless other organisms gain entrance no general rot develops. The infected part slowly extends and is somewhat sharply differentiated from the surrounding healthy tissue. At first it is water-soaked in appearance, then turns whitish in the centre, dries and cracks. The characteristic exudate appears on the surface.

When female flowers become infected they do not set, but turn yellow, then blacken and dry up.

Cause. The bacteria that cause this disease gain entrance to the plants mostly through the stomates (breathing pores). They spread rather slowly through the intercellular spaces, crowding apart and crushing the tissue cells. They come to the surface with the exudate that oozes from the diseased parts, and from this location they may be washed by rain to nearby healthy plants, or carried by insects, cultivators or the hands of workers. The organism may be carried over winter on contaminated seed.

Control. Seed treatment—immersion for 5 minutes in corrosive sublimate 1-1000 has proved safe and effective; while treatment with 4 per cent. formalin proved injurious to the seed. Spraying plants with Bordeaux mixture checks spread of the disease. Keep insects in check.

MOSAIC OF CUCUMBERS. This disease is often seen in Ontario. It quite frequently causes very serious loss to cucumber growers. It is known by various names such as Mosaic, White Pickle, White-wart and Nubbin disease.

Symptoms. Plants may show symptoms of the disease in any stages of their growth. If seedlings are diseased the seed leaves (cotyledons) turn yellow. The leaves are mottled yellow and green and the plant is much dwarfed. There is little or no fruit set and the plant usually dies early. Generally plants do not show symptoms of the disease until they are passed the seedling stage. The peculiar yellow and green mottling of the foliage is the first symptom. The upper surface of the leaf is wrinkled and its edges curled downward. The affected leaves are dwarfed and the fruit does not set properly. If the fruit is affected it shows alternate irregular yellow and green spots, the latter being raised on wart-like projections.

Cause. This is another of the so-called virus diseases. The virus which causes it is not carried over in the soil or in the seeds of the cucumber or other cultivated vegetables. It has been demonstrated however, that it can live over the winter in the seed of the Wild Cucumber (Echinocystis lobata) and in the perennial roots of the milkweed, pokeweed and ground cherry. Aphids and the striped cucumber beetle serve to transmit the virus from diseased to healthy plants. It may also be transferred by rubbing together healthy and diseased leaves until there is bruising, or by other methods in which the plant sap may be transferred from a diseased to a healthy vine.

Control. No entirely satisfactory control measures have been devised. Spraying or dusting for the eradication of insects as suggested for the control of Bacterial Wilt is recommended. Wild cucumber, milkweed, pokeweed and ground cherry growing in the neighbourhood of the greenhouses and cucumber fields should be destroyed if possible. When diseased plants are noticed in the greenhouses they should be pulled up by the roots, carefully removed and burnt. If they are large and entwined with other plants pull them up by the roots and leave on the trellis so that the disease will not be spread by bruising healthy plants while removing them.

POWDERY MILDEW OF CUCUMBERS. This mildew is seen on squash, cucumbers and melons. In Ontario it is seldom of any importance in the field but sometimes becomes troublesome on cucumbers grown under glass.

Symptoms. Circular powdery spots are seen on the leaves and young stems. At first the tissue of the spots remains normal but finally turns brown and dried. In severe attacks the leaves may be killed. If all the foliage of the vine is covered with mildew the plant is weakened, has a yellowish colour and most of the fruit is rendered useless.

Cause. Erysiphe cichoracearum D.C. is the name of this mildew. This fungus produces two kinds of spores, summer spores (conidia) which are produced in enormous quantities in chains on the surface of the leaves and which give to the spots their powdery appearance. These summer spores serve to spread the fungus during the growing season. The second form of spores known as ascospores are produced in little black fruiting bodies (perithecia) on the surface of the leaves and petioles. They serve to carry the fungus over from season to season.

**Control.* This mildew can be prevented by dusting with sulphur or spraying with Bordeaux at intervals of a week or ten days. Sulphur dust is most effective for combatting powdery mildew in greenhouses. Sulphur dusting materials containing fifteen to twenty per cent. free sulphur are as effective as high grade dusts containing sixty to ninety-five per cent. free sulphur, and are safer, cheaper and therefore preferable. E. F. Guba states that dust should be applied at the rate of about 5 to 6 pounds to a house 280x40 ft. Bordeaux mixture of the strength of 1 pound of copper sulphate, 2 pounds of hydrated lime and 40 gallons of water can be safely used. Experiments have shown that if greenhouses are fumigated with hydrocyanic acid gas when Bordeaux is present on the leaves foliage injury may result.

*"Control of Cucumber Powdery Mildew in Greenhouses" by E. F. Guba, Phytopathology, Volume 18, No. 10, October 1928.

ANTHRACNOSE OF CUCUMBERS, SQUASH AND WATERMELONS. This is a disease which is frequently seen in Ontario, especially on cucumbers. It is seldom serious in the field but occasionally becomes very severe on cucumbers grown under glass.

Symptoms. On the leaves of affected plants brown dead circular spots are seen. These are frequently very numerous so that the whole leaf is destroyed. On the stems elongated light brown areas are observed. On affected fruit especially on the watermelon, water soaked sunken spots appear. These often have pink centres.

Cause. Anthracnose is caused by the fungus Colletotrichum lagenarium (Pass.) E & H. This fungus remains alive in the old diseased tissue in the soil in the field or in the greenhouse. It is also known to be carried over in and on the seed.

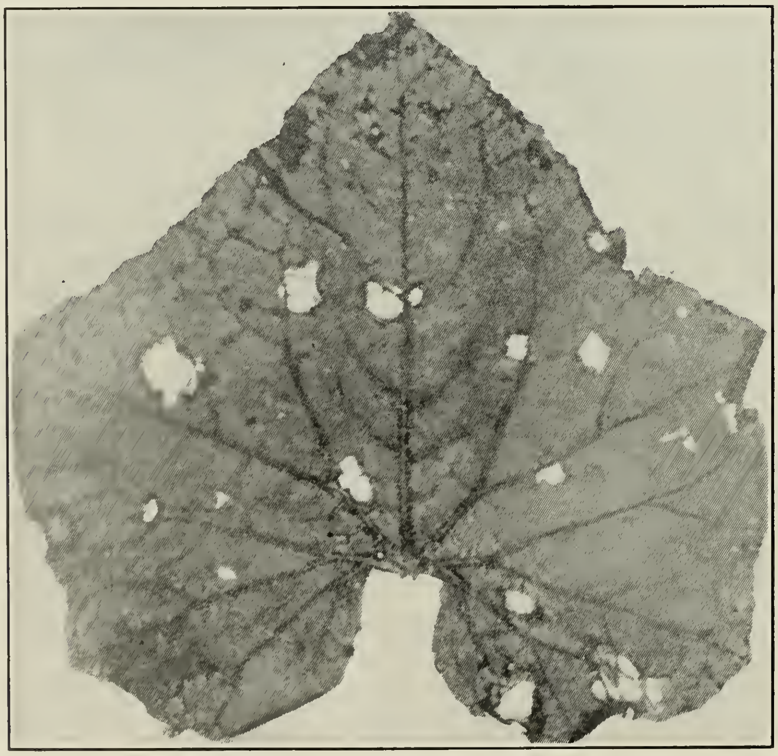
Control. No satisfactory control measures have been discovered. As the fungus lives over at least one season in the diseased plant refuse left in the soil, a rotation of crops is essential. Seed treatment is also recommended. This consists of dipping the seed in corrosive sublimate (1 ounce in 6 gallons of water) for 5 minutes then rinsing it thoroughly in running water and drying it. Spraying with Bordeaux mixture is also recommended. Spraying cucumbers under glass has not been profitable in the limited experiments carried on in this Province as the frequent and heavy sprayings required to control the disease have caused injury to the foliage and fruit.

Downy Mildew of Cucumbers. This disease is quite frequently seen in Ontario. It affects not only cucumbers but also squash, melons and pumpkins.

Symptoms. Irregularly shaped yellowish spots appear on the upper sides of the leaves. If a leaf is examined on the lower surface of the spots around the margin will be seen a downy fungus growth. If weather conditions are favourable these yellowish spots rapidly enlarge and finally the entire leaf withers up and dies.

Cause. Peronoplasmopora cubensis (B. & C.) Clint. is the fungus which causes this disease. This fungus spreads during the wet weather of the summer months by means of numerous spores produced on the under surface of the affected leaves. Just how this fungus passes the winter is not known. It is possible that it may survive the winter in greenhouses and spread to outdoor plants when the latter begin to grow. There is no evidence that it lives over in the soil outdoors.

Control. Spraying with Bordeaux mixture or dusting with copper lime dust will control this disease. Begin spraying or dusting early. In comparatively dry weather apply the Bordeaux or dust every ten days. If however, the weather is wet more frequent applications will be necessary. When the plants are young weak Bordeaux should be used (2 pounds copper sulphate, 4 pounds hydrated lime and 40 gallons of water). Later when the plants have formed runners the 4-8-40 formula can be used. In spraying or dusting it is important that both sides of the leaves should be covered with the fungicide. Frequent and heavy applications of Bordeaux applied to cucumber plants under glass may cause injury to foliage and fruit.



Downy Mildew of Muskmelon.

(After F. C. Stewart.)

LETTUCE

LETTUCE DROP. This is a serious disease of lettuce. It is frequently seen in Ontario on lettuce grown under glass.

Symptoms. The first symptom usually observed is the wilting of the outer leaves which droop and fall flat on the ground. All the leaves of the plant are soon affected in the same way and in a few days the entire plant is dead and lying flat on the ground. This sudden and entire collapse of the plants has given rise to the name "Drop". The disease usually appears on the stem near the surface of the soil as a soft water-soaked spot that spreads downward until the roots are decayed and upward until the bases of the leaves are affected.

Cause. The most common cause of leaf drop is the fungus Sclerotinia libertiana Fckl. This fungus forms innumerable black hard bodies termed sclerotia. These are a resting stage of the fungus and they serve to carry it over from season to season.

Control. Soil sterilization is the most important control measure. Either steam or formaldehyde may be used (See page 60). If a few diseased plants are seen in a bed they should be removed, taking care not to scatter any of the diseased tissue or sclerotia. After the plants are removed soak the vacant spot with a bluestone solution, 1 pound in 6 gallons of water. Keeping the top soil well stirred and as dry as good growth of lettuce will permit, helps to prevent the development of this disease. If possible a system of cropping should be so arranged as to alternate crops of lettuce with less susceptible vegetables such as radishes and tomatoes.

Two other fungus diseases, the Downy Mildew (*Bremia lactucae,* Reg.) and Leaf Spot (*Septoria consimilis* Ellis & Martin), are seen on lettuce to some extent in Ontario, but never seem to be serious enough to require any special attention when the crop is properly managed.

BACTERIAL ROT OF LETTUCE

(1) *Phytomonas viridilivida,*

(2) *Phytomonas vitians, and*

(3) *Phytomonas marginale by N. A. Brown, S.A.B.*

Losses in the lettuce crop ranging from five per cent. to fifty per cent. or over, both in greenhouse and in field, have been traced to certain species of bacteria from the soil gaining entrance to the plant tissues.

Usually, however, if not invariably, such crops have been grown under abnormal atmospheric or soil conditions which have rendered the plants peculiarly susceptible to bacterial invasion and development. A stagnant, humid, warm atmosphere such as prevails in poorly ventilated greenhouses where the plants are excessively watered by spraying, or out in the open field during a prolonged warm, wet spell, or under the covers sometimes spread over the lettuce crop for night frost protection, has been shown to be particularly inducive of conditions in the plant tissues favouring bacterial invasion. Soils heavily treated with loose lightly rotted manure or compost have also been found to greatly favour the development of these lettuce rots.

Symptoms. In the lettuce rot caused by *Phytomonas viridilivida* the outer leaves of heads are mostly affected. The disease first appears as water-soaked areas surrounding point of inoculation. These areas converge and turn yellowish brown, and rot sometimes with a soft rot and other times with a dry rot, leaves shrivelling. The bacteria enter through the stomates (breathing pores), also through wounds made by insects and during handling. The disease is most in evidence after prolonged wet weather.

Control. Good results have been obtained from spraying infected plants with formalin, one pint to thirty gallons of water.

In the early stages of the lettuce rot caused by *Phytomonas vitians* the affected plants are a lighter green colour than healthy ones; later the head may show rot through the centre or only on top. A general wilting of the head may occur, with or without visible spots or rot. In some cases rotting is rapid; in other the heart remains sound while the outer encircling leaves are in a bad state of decay. The diseased plants are not firm in the soil, the stem is brittle and can be easily broken off at the surface or a little below the surface of the soil. In an early stage of the disease the stem, when cut across, shows a blue green colour; in a later stage it is brown. If the disease attacks a young plant no head will form. There are also cases where the stem remains sound and only the leaves are affected, these leaves having definitely outlined spots. In others the spots have coalesced, making a darkened mass of diseased tissue.

Control. As the worst cases of this disease have been found in land to which large quantities of only slightly decomposed manure and compost were added, making a very loose substratum for the roots, and thus producing plants of low resistance to bacterial invasion, it is recommended that only well rotted manure and compost be used on the land preceding the lettuce crop.

In the lettuce rot produced by *Phytomonas marginale* the symptoms are quite striking. At first there is usually a slight marginal wilting in more or less localized areas on leaves in the same whorl. These areas on the leaf margins may vary from mere specks to an inch or an inch and a half long, and may coalesce. On the older leaves the most common sign is wilting of the tips. The areas affected lop over and gradually become dry. The vascular tissues at this stage frequently show a distinct browning. In a few days the affected areas turn brown, tan, reddish and sometimes black. The tissues become dry and papery in texture. This disease does not usually extend down the entire leaf. It does not cause an extensive rot or soft decay of lettuce, but mars its appearance so that it is not saleable. Leaf lettuce is less liable to the disease than head lettuce.

Cause. Bacteria are found in large numbers in the more recently affected tissues. They gain entrance through the stomata when the leaves are in a weakened condition owing to cold, high humidity and excessive watering.

Control. Guard against high humidity and excessive watering. See that greenhouse is well ventilated.

ONIONS

ONION SMUT. This is a very injurious disease. It has become very prevalent and very destructive in several of the important onion growing districts of Ontario.

Symptoms. It appears only on onions grown from seed. It frequently destroys large numbers of the seedlings soon after they appear above the ground. The leaves of affected seedlings become curled and twisted and dark streaks show within the tissues. These streaks are filled with a dark brown powdery mass. Diseased seedlings that are not killed in the early stages, often die later or produce small, distorted bulbs with black streaks. If these black streaks are broken open they are found to be filled with a black mass of smut spores.

Cause. Onion Smut is caused by the fungus Urocystis cepulae Frost. This is a soil organism that may live in the ground for many years. It can infect onions only for a brief time during the development of the seedlings. The period of infection extends from the time of germination until the seedlings are in the first leaf. This is usually about two weeks. Once the seedlings have passed this stage the fungus cannot infect them. The spores of the fungus are carried from place to place on onion sets, by running water or in the soil adhering to implements, the feet of men and animals and the roots of other vegetables.

Control. A formalin solution applied when the onion seed is being sown has given excellent results in the control of this disease. The formalin is applied by means of a tank and drip attachment on the onion seeder. Numerous experiments have been conducted in the Pelee marshes and the best results have been obtained from the following solutions:

(1) Formalin, 1 pint to 15 gallons of water, applied at the rate of 150 gallons per acre; (2) Formalin, 1 pint to 10 gallons of water, applied at the rate of 100 gallons per acre. The latter solution cuts down to a minimum the amount of water that must be used and thus reduces the labour to a considerable extent. This is an important factor.

The formalin method is the one which is now extensively used by commercial onion growers and it is the only satisfactory treatment when large quantities of onions are grown. Those who grow but a few onions for their own use can prevent onion smut by sowing the seed in smut-free soil, and then transplanting the seedlings after they are passed the susceptible stage. They can also avoid it by growing their onions from sets instead of seed.

Onion Blight or Downy Mildew. This is a very common disease of the onion in Ontario and in some parts of the Province it frequently decreases very materially the onion crop by destroying the leaves and thus reducing to a marked extent the size of the bulbs.

Symptoms. These are usually first noticed in late June or July. Affected leaves show peculiar violet-tinted areas due to the fuzzy spore-bearing portions of the fungus on the surface. They very soon become pale or yellowish in spots and collapse and break down. In severe attacks all the leaves in a field or patch are very soon destroyed. They are often however, quickly replaced by a new crop which in turn may be destroyed by the disease and from this second attack the onions do not usually recover.

Cause. This disease is caused by the fungus Peronospora schleideni Unger. Two kinds of spores are produced by this fungus, namely thin-walled summer spores borne on the minute, branched spore-bearing part of the fungus covering the surface of the attacked leaves, and thick-walled resting spores (oospores) formed in the tissues of the dead leaves. The summer spores are freely scatttered by wind during the summer and new leaves become infected. In this way the disease is spread very rapidly especially during damp muggy weather. Dead leaves containing the thick-walled resting spores lie on the ground during the winter and in the spring these spores germinate and give rise to the disease if onions are planted on the same ground again. The fungus also lives over as dormant fungus threads (mycelium) in the onion bulbs and sets.

Control. Rake up and burn the diseased tops as by so doing many of the resting spores will be destroyed. If possible practice a rotation of crops as the fungus is carried over the winter by the resting spores in the soil and it is believed that they retain their vitality for two or three years. The choice of land for the growing of onions is important. The soil should be well drained and wind barriers such as woods, hills and weeds should be eliminated as far as possible, so that there will be a free circulation of air over the field which will dry the plants quickly after rain and heavy dew. When growing onions from sets or planting seed bulbs it is important that these should not be taken from fields where onion blight has been prevalent. Spraying with Bordeaux with a sticker has been recommended by some American authorities. At best it is a difficult task and so far there is no experimental evidence to show that it is profitable here in Ontario. However, in those sections of the Province where onion blight causes serious loss nearly every year, spraying in conjunction with the other methods of control should be given a fair trial. Spray with Bordeaux mixture, 4 pounds bluestone, 8 pounds hydrated lime and 40 gallons of water. To this mixture add 3 pounds of resin fish oil soap as a sticker. The spraying should be started if the weather becomes wet towards the end of June and an application made at least once a week if it is a wet season. In order to avoid destroying the onion plants the sprayer (if a power outfit) should be equipped with a very long boom and many nozzles or with two or more leads of hose so that a man at the end of each hose may spray three or four or more rows at a time.

ONION SMUDGE. This is a disease which is common in Ontario. In wet seasons it seriously disfigures white onions. It does little or no harm to yellow or red onions.

Symptoms. The most pronounced symptom is the dark green or black smudge on the bulb or neck of the onion. Sometimes the surface of the smudge spots is uniformly black. Frequently however, the black smudging is in concentric circles. The smudging may be so extensive as to cover the greater portion of the bulb and disfigure it very badly. In severe cases the fungus grows through the outer scales into the living tissue below, causing collapse of the fleshy scales. The disease may appear at any time in the life of the onion plant in storage or during transportation as well as in the field. Sometimes it causes a damping off of the seedlings. This symptom of the disease has not been observed in Ontario.

Cause. This disease is caused by the fungus Colletotrichum circizans (Berk.) Vogl. This fungus passes the winter on onions, on sets and in the soil. It is only under the most favourable conditions of moisture and temperature that it can attack growing onions and cause disease. It is carried long distances on bulbs and sets, and possibly on the seed. Most of the infection takes place in the field. This fungus develops best in relatively high temperatures (75 to 80°F) and requires relatively high soil moisture. It causes most damage when we have hot damp weather shortly before harvest time.

Control. No entirely satisfactory control measures are known. Careful harvesting of the bulbs and thorough drying before placing in storage help to reduce the injury caused by this disease. Practicing a rotation of crops so as to not grow white onions on the same piece of land oftener than once in every three or four years should reduce the loss from this trouble. This disease can be avoided by growing the resistant coloured onions in place of the white or silver-skinned varieties.

BLACK MOULD. This disease frequently follows downy mildew or blight.

Symptoms. The leaves become blackened and covered with a thick brownish-black fungus growth.

Cause. This disease is caused by the fungus Macrosporium parasiticum Thumen. This is a weak parasite and seldom if ever appears in abundance on perfectly healthy plants.

Control. No special control measures are required beyond keeping the plants as free as possible from blight and in a healthy growing condition.

PEAS

ROOT ROT AND BLIGHT. In the eastern sections of Ontario, especially in Prince Edward County, this disease has been a serious handicap for many years. Some men have been forced to give up pea growing entirely or to abandon the crop for several years. Frequently a whole field of peas will die down just about flowering time and produce little or no seed.

Dr. R. E. Stone of the Botanical Department has made a special study of this disease and the following account of it is based on his observations and experiments.

Symptoms. The disease generally becomes noticeable just about the time that the peas are coming into bloom, although in severe cases it may be noticed earlier than this. The lower leaves turn white or grey and in a few days or a week the plants wilt down. The roots of such plants are usually brown and rotten. The outer layers or cortex slough off readily and the little feeding roots are all destroyed. On the stem just at the surface of the ground there is generally a blackened area.

Cause. This disease appears to be due to two fungi—a species of Fusarium and a species of Pythium working on the pea plants. These are soil fungi, that is, they are capable of living in the soil for a considerable period of time.

Control. First, crop rotation; second, the use of resistant varieties.

If this disease has been very serious a rotation of crops should be followed in which peas are not grown on the same soil oftener than once in five years.

Field tests in Ontario have shown that the following varieties of peas are those most resistant to root rot and blight: Green Admiral, Yellow Admiral, Rice's 330 and Horal.

BLIGHT OR LEAF SPOT OF PEAS. This disease is commonly seen in Ontario but seldom causes enough injury to attract attention.

Symptoms. Stems, leaves, pods and seeds are affected. Stems of infected plants show discolored areas of dead tissue, sometimes extending completely around them, destroying the shoot. Diseased leaves show round or oval discolored spots from ⅛th to ½ inch in diameter. On the pods sunken spots much like those of bean anthracnose are seen, but pale in colour.

Cause. This disease is caused by the fungus Mycosphaerella pinodes (Berk. and Blox.) Stone. This fungus passes the winter chiefly as dormant fungus threads (mycelium) in the seeds.

Control. So far it has not been necessary to practice any particular control measures for this disease in Ontario. If it should become serious non-infected seed should be sown. This can be obtained by selecting it from healthy pods. Spraying with Bordeaux mixture beginning when the plants are from 2 to 4 inches high and repeating at intervals of 5 to 10 days, according to the weather, is also recommended. Such treatment would not be worth while for the general crop but it might be advisable to apply it on a small scale to plants set apart for seed production, since healthy pods bear healthy seeds and healthy seeds will produce a clean crop the following year.

POWDERY MILDEW. This disease is frequently seen in Ontario but seldom causes serious damage.

Symptoms. Leaves, stems and pods become covered with a whitish or greyish mildew. Later minute black fruiting bodies (perithecia) are to be seen scattered over the mildewed surfaces.

Control. This disease is seldom injurious enough to call for any special treatment. Experiments conducted in the United States have shown that it can be controlled by spraying with Bordeaux mixture, 4 pounds copper sulphate, 8 pounds hydrated lime and 40 gallons of water. One or two applications should be given.

BACTERIAL WILT OF FIELD AND GARDEN PEAS

(*Phytomonas pisi*) *Sackett, S.A.B.*

Though we have occasionally found this disease in pea crops in Ontario, it has not, so far as we are aware, been reported as causing heavy losses in the Province such as it has caused in some parts of the United States.

Symptoms. This disease occurs as canker on the lower part of the stems and as a podspot and leaf spot, and it may also be found as a spot on the seed peas within infected pods.

When the disease gets established in young plants three or four inches high, the upper leaves will have a bruised, watery, yellowish appearance and the lower leaves be dead or dying. The stems of such plants are almost always dark brown or black and considerably shrivelled. Such plants usually die.

In somewhat older plants that are six or eight inches high, where the infection appears to have taken place at a later period, the diseased part of the stem is watery, olive-green to olive-brown in colour. The leaves attached to it first become limp and discoloured in the same way, and later die, turn brown and shrivel up.

The root and that part of the stem below ground do not usually become affected. The stem infection starts in most cases about an inch above the ground line and moves up the stem towards the growing tip. Droplets of a pale yellow exudate are occasionally found on the diseased part. Sometimes below the diseased area on the stem the plant will throw out two or three fresh branches, which under favourable conditions may produce healthy tops, though as a rule they do not make the rank and vigorous growth characteristic of the earlier ones.

If the vines become diseased when they are small and the main vine dies before branching takes place, the chances are that no branches will be formed and the plant will be killed outright.

The leaves may develop the disease independently of any other structure and die before the stems show any trace of the trouble.

On pods the disease first appears as small, water-soaked spots which gradually enlarge, turn yellowish and then brown. If young pods are infected severely they shrivel up and die. Where diseased pods mature, the seed inside may have the disease established in them near the hilum, and the surface of the seed may be coated with the bacterial exudate from the diseased interior surface of the pod.

Cause. The bacteria gain entrance to the plants mostly through wounds but also through the stomates. They feed on the plant juices and spread through the surrounding tissue by means of the intercellular spaces. They do not get established in the vascular system.

Control. The bacteria overwinter in the form of a dry bacterial film on the surface of the seed from diseased pods, and also in the seed coat. They will live under such conditions for at least ten months. When infected seed is sown, a certain percentage of plants coming from it will be infected; and such infected plants are centres for the dissemination of the disease in the field.

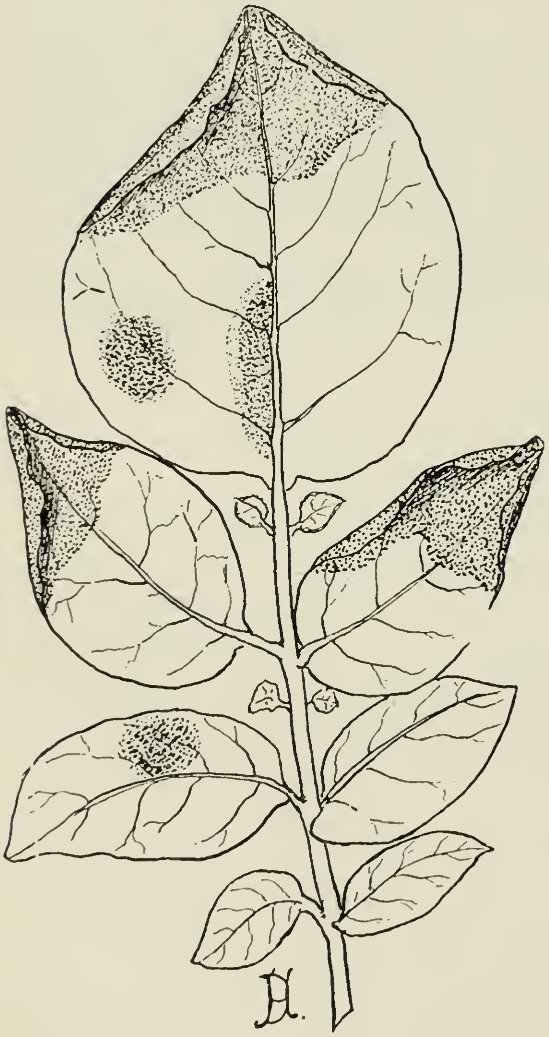
Use seed from crops that are known to have been free from the disease.

POTATOES

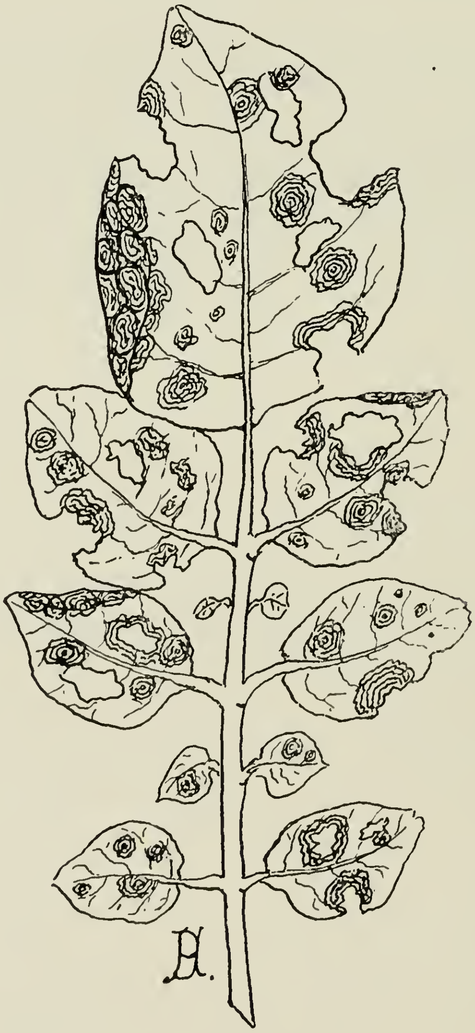
LATE BLIGHT AND ROT OF POTATOES. This is the most destructive disease of potatoes in the Province. In wet seasons it frequently destroys a large proportion of the crop. The effects of the disease are not noticed usually until late summer—August or September. Frequently however, if the weather is wet about the middle of July the disease may be observed in the fields by the middle or end of the month. It is always worse on low lands and on the heavier types of soils.

Symptoms. This disease as the name implies causes a blighting of the leaves and a rotting of the tubers. The blight is usually seen first on the lower leaves generally at the margins. On the infected leaves irregular dark spots or blotches are observed. These have a water-soaked appearance when held up to the light. On the under surface of these blotches especially around the margin a delicate white fungus growth may frequently be seen. In wet weather the blotches enlarge rapidly and the whole leaf is involved, becomes soft, brown, rotten and droops. In this way all the tops may be destroyed in a few days. If dry weather checks the development of the disease the spots do not enlarge but become dry, brittle and brown. On some of the infected tubers pits or more or less depressed areas are seen. Sometimes these have a somewhat purplish or reddish tinge and a water-soaked appearance. If the diseased potatoes are cut, a rusty brown dry rot is seen in the flesh just beneath the skin. Infected tubers dry rot in the field or in storage. Tubers when dug may show no signs of rot but if they have been produced by blighted plants, the rot is very likely to develop in about three weeks after they are placed in storage. A wet soft rot often develops in wet seasons. This is frequently seen when the potatoes are dug and is due to secondary organisms which gain entrance to the tubers through the dead areas produced by the fungus which causes the Late Blight and Rot.

Cause. Late Blight and Rot is caused by the fungus Phytophthora infestans (Mont.) De Bary. This fungus is rapidly spread through the crop during wet weather by means of numerous spores produced on the lower surface of the affected leaves and scattered by rain, wind and insects. Some of these spores are washed off the leaves down through the soil on to the tubers which they are able to infect. Tubers are also often infected by coming in contact with blighted tops and contaminated surface soil when they are being dug. The fungus is carried over the winter chiefly as

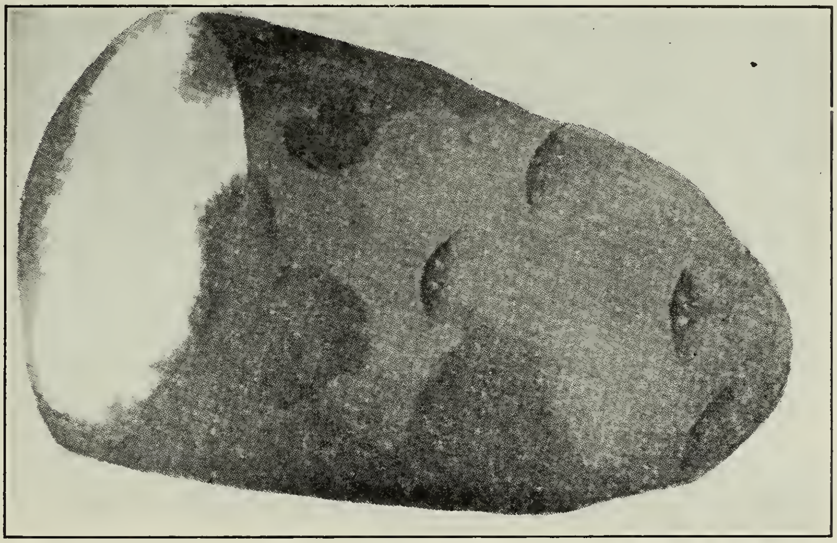


Late Blight.



Early Blight.

fungus threads (mycelium) within infected tubers. Slightly infected tubers show little or no external evidence of the disease. When infected tubers are used for seed the fungus threads may develop in them and produce spores on the surface of the seed pieces or the fungus threads may grow up into the sprouts and produce spores on the outer surface of the growing shoots. The spores produced on the seed pieces or on the developing shoots may be washed or splashed by rain to the leaves which they are able to infect. These infected leaves soon develop blight. There is also some evidence to indicate that the fungus may be carried over as resting spores in the diseased tops. This however, has not been demonstrated in Ontario. The conditions which favor the development of this fungus are excessive moisture, cool nights and warm days.



Characteristic Rot due to the Late Blight and Rot Fungus.
(After Gussow.)

Control. Spraying with Bordeaux mixture is the most reliable means of preventing Late Blight and Rot. Commence spraying when the potato beetle eggs are just hatching, which will usually be when the potato plants are from five to eight inches high, and keep the foliage covered with Bordeaux throughout the season taking special precautions to see that it is well covered during wet weather. Do not put off spraying because it looks like rain for once dry the spray mixture will remain on the leaves and be on at the critical time. This statement will be understood when it is realized that infection takes place during or immediately after rain. For the first application use Bordeaux mixture (formula 4 pounds copper sulphate, 6-8 pounds hydrated lime and 40 gallons of water). Add 2 pounds of arsenate of lime (calcium arsenate) to each 40 gallons. Repeat the spraying often enough to keep the foliage well covered. Add the arsenate of lime to the Bordeaux only when required for potato beetles. No stated number of sprayings with the Bordeaux can be recommended; the number depends on the weather—the wetter the weather the larger the number. If the season is favorable for Blight and Rot continue the spraying until the plants have finished their growth and died or have been destroyed by frost. It is very important to use plenty of Bordeaux at each application. Forty gallons may be sufficient to cover an acre of potatoes when the plants are small but when the plants are large from eighty to one hundred gallons or more may be required for each acre. The best results are obtained by applying the Bordeaux under high pressure in the form of a fine mist so as to cover both surfaces of the leaves. High pressure power sprayers which deliver plenty of the Bordeaux to thoroughly cover the vines are the most satisfactory machines for spraying.

Dusting is sometimes practised instead of spraying. Copper-lime dust is used. On the whole the results from dusting have not been as satisfactory as those from spraying. Some growers, however, prefer dusting to spraying because it requires less time. The best results from dusting are obtained from frequent and heavy applications of the copper-lime dust.

Other means which can be used to lessen loss from this disease. Plant the more rot resistant varieties of potatoes (See O.A.C. bulletin 239). Avoid soils that are not thoroughly underdrained either naturally or artificially. Plant certified seed potatoes. These are potatoes known to be comparatively free from disease. When the vines are blighted allow them to die and become thoroughly dry before digging the potatoes. Remove the potatoes from the field as soon after digging as possible. Sort them carefully and store in a cool, dry cellar, spreading out as thinly as possible. The proper temperature for storage is about 38°F.

EARLY BLIGHT. This disease is common and in some years causes noticeable damage. It sometimes appears when the plants are small but it is most abundant about the time the potatoes are in blossom. In severe cases the foliage is badly damaged and the tubers remain small. Unhealthy plants and those attacked by the flea beetle suffer most from this disease.

Symptoms. Small scattered greyish-brown circular spots are first observed on the leaves. These take on a minutely velvety appearance and gradually become larger and sometimes run into each other until in some cases half the leaf may become brown and curled. As the spots enlarge faint concentric rings appear on them described as "target brand" markings. Leaves which are very badly spotted turn sickly yellow in colour.

Cause. The causal fungus is Macrosporium solani E. & M. This fungus is carried over the winter by means of spores in the soil and by fungus threads in diseased potato tops and weeds.

Control. Spray with Bordeaux mixture as directed for Late Blight and Rot. Take special care to see that the early applications are very thoroughly applied. A three to five year rotation of crops will also help control this disease. Weeds closely related to the potato such as Nightshade and Ground Cherry should be destroyed as they harbour the causal fungus.

COMMON SCAB. This scab is familiar to nearly every potato grower. It is however, not confined to the potato but is sometimes seen on garden beets, sugar beets, turnips and radishes.

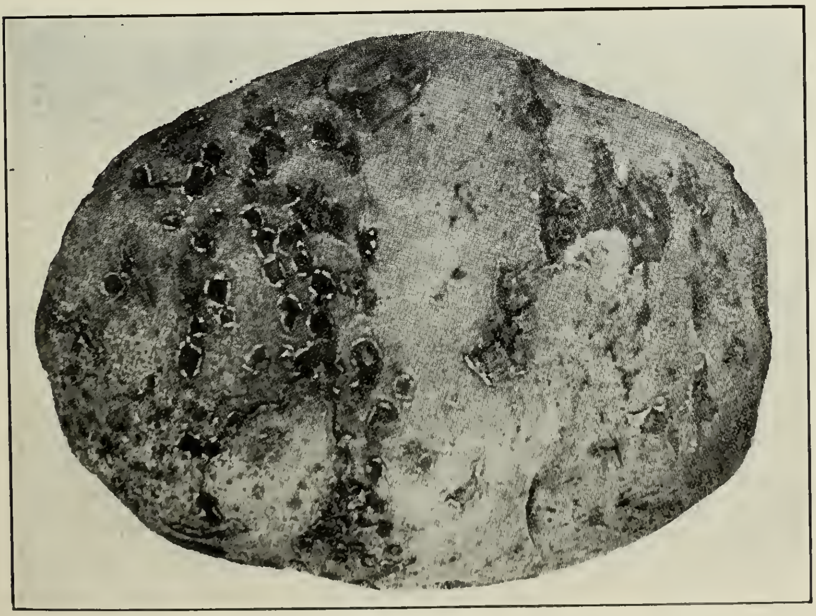
Symptoms. It is easily recognized by the roughened corky spots on the skin of the tubers. These may be few and scattered or numerous and close together so as to disfigure badly the potatoes. Sometimes there are also blackened pocket-like cavities. Scab does not injure the flesh of the tubers to any great extent but it renders them unsightly and hence not readily saleable when potatoes are plentiful.

Cause. Common scab is caused by one of the higher bacteria known as Actinomyces scabies (Thax.) Gussow. This organism is carried over the winter on seed potatoes and in the soil. It remains in the soil for several years after a crop of scabby potatoes has been produced. It will also pass through the intestines of stock fed on scabby potatoes. This organism appears to be native to some soils. A few scabby potatoes in a bag may contaminate the whole lot. It thrives best in an alkali soil and is checked by acidity. It develops most readily in a soil rich in organic matter and at a comparatively high temperature.

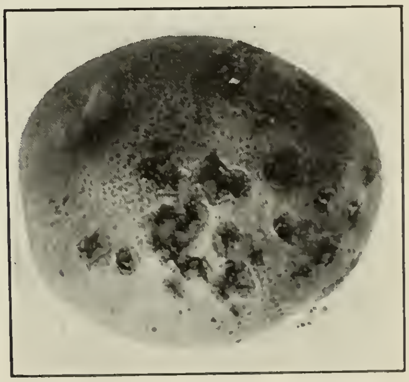
Control. When a field is thoroughly infested with the scab organism it is very difficult to grow a clean crop on it. There are however, certain recommendations which if put into effect will reduce very markedly the amount of scab. Follow a rotation of crops. If scab is very bad it is not advisable to plant potatoes on the same land oftener than once in five years. Plant potatoes after clover sod if possible. Heavy applications of barnyard manure should not be made direct to the potato crop but if necessary given at some other point in the rotation. Avoid alkali fertilizers such as lime and wood ashes. If commercial fertilizers are used they should be of an acid nature. Sulphur and inoculated sulphur have been recommended by some authorities for the prevention of scab. The results obtained in experiments here at the College with sulphur and inoculated sulphur are not such as to warrant the recommendation of either of them for the prevention of scab. Treating the seed potatoes with formalin or corrosive sublimate helps to lessen the amount of scab. The effectiveness of seed treatment varies with different soils. On some soils it is very effective while on other soils the results are far from satisfactory, probably due to the fact that the soil is heavily infested with the scab parasite and in such a condition as to favour its development.

Directions for treating seed potatoes with formalin to prevent common scab.

Select tubers free from all signs of rot and bruises and as free as possible from scab, and disinfect them before they are cut by soaking them for two hours in a solution made by adding one pint of commercial formalin to thirty gallons of water. The same formalin solution can be used to treat



Powdery Scab (after Morse).



Common Scab. (Original.)

successive lots of potatoes. Thirty gallons is sufficient to treat from forty to fifty bushels if ordinary precautions are taken not to waste the solution when dipping. Wash all crates, bags etc. which are used in handling the potatoes with the formalin solution. After the potatoes are removed from the solution they should be spread out on clean grass or clean bags to dry. If the potatoes are not all disinfected on the same day it is advisable to make up a fresh supply of formalin for each days treatment. (See note on formalin, page 60).

Directions for treating seed potatoes with corrosive sublimate to prevent common scab. (*See page 39*).

POWDERY SCAB. This disease was first reported as occuring in Canada about 1912. It was found in Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Alberta. In 1914 it was reported from Northern Ontario. It does not seem to be established in the southern parts of the Province. It does not appear to cause serious trouble in warm, comparatively dry soils.

Symptoms. Tubers infected by the Powdery Scab fungus become covered with conspicuous scab spots which are more clearly defined, more elevated and smoother on the surface than Common Potato Scab. When the skin of the scab spot is broken the cavity beneath is seen to be filled with a brownish or greenish powder. The chief injury is the unsightly appearance of the tubers. In very severe cases however, the potatoes may be stunted and malformed and there is always a greater tendency for infected tubers to shrivel and dry rot in storage.

Cause. The cause of Powdery Scab is a slime mould known as Spongospora subterranea (Wallroth) Johnson. This fungus is spread mainly on seed potatoes. It is introduced into new localities chiefly through planting "seed" which is infected or which has come in contact with infected tubers or with bags, crates, implements, etc. which have been used in handling them. Once the fungus gains entrance to a soil it will apparently remain there for a number of years. It develops best in wet cool soils and it will not develop in warm, comparatively dry soils.

Control. Secure seed potatoes from a district known to be free from Powdery Scab. Plant only sound tubers free from scab and as a precaution disinfect them with either corrosive sublimate or formalin. (See directions under Common Scab, page 39). Good drainage and a long rotation of crops will also aid in the control of this disease.

RHIZOCTONIA OR BLACK SCURF. This disease is very frequently met with in Ontario and in seasons of excessive rainfall often results in a noticeable reduction of the crop. It does more damage in Northern Ontario than it does in the southern parts of the Province.

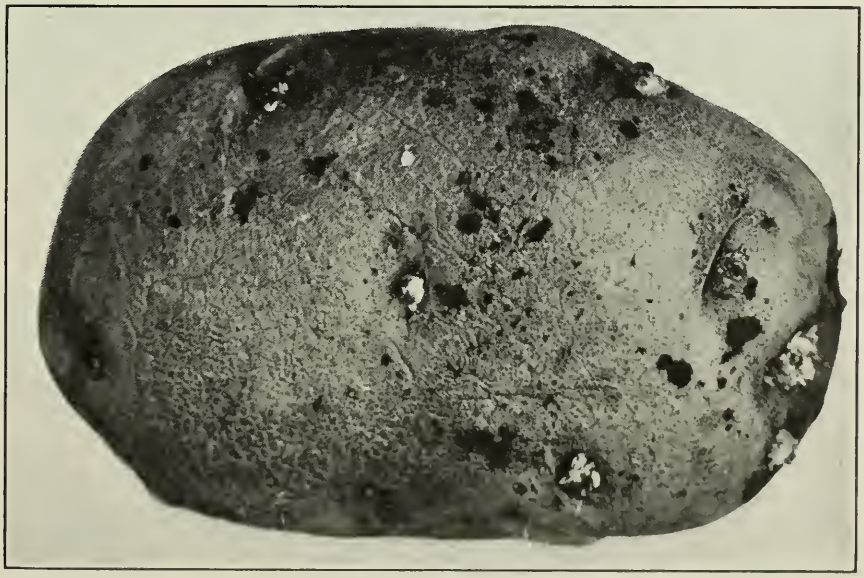
Symptoms. Tubers are very frequently seen with what appear to be lumps of hardened soil adhering to them. These are black in colour when wet. They vary in size from mere specks to one-quarter of an inch in diameter. Sometimes they are very numerous and quite noticeable. They are known as sclerotia and consist of compact masses of resting fungus threads (mycelium). The skin of the potato beneath them is often roughened and russeted but the flesh of the tuber is not injured to any appreciable extent. If potatoes however, with these sclerotia adhering to them are planted the fungus may spread into the developing sprouts and kill them before they get above the ground. This is one cause of "misses" in the rows. Later in the season several other symptoms may develop. Young shoots may wither and die and if they are pulled up and examined there will be found near the base of the stems brown dead areas often encircling them. Sometimes large plants become sickly yellow and develop many fine spindly shoots. Such plants also show dead brown areas near the base of the stems and on the underground parts. Occasionally at the base of the stems of affected plants clusters of small tubers may be found and quite frequently small greenish potatoes are seen on the stem above the ground. Such aerial tubers are very characteristic of the disease but they may result from other causes such as injury to the stem by cultivation.

Cause. This disease is caused by the fungus Corticium vagum B. and C. This fungus attacks many plants besides the potato. Among the more important hosts of this fungus are carrots, beets, beans, cabbage, parsnips, onions, turnips, peas, celery, rhubarb, spinach and lettuce. The fungus lives over winter in the soil and on the tubers in the form of fungus threads (mycelium) and sclerotia. It is probable that few soils are free from it.

Control. Dig the potatoes as soon after they are mature as possible. The longer they are in the soil, especially in a wet fall, the greater the chance of sclerotia developing on them. Treat the seed potatoes with corrosive sublimate before they are cut for planting. This seed treatment should be done when the potatoes are dormant, that is, before the buds in the eyes begin to grow.

Directions for treating seed potatoes with corrosive sublimate to prevent rhizoctonia and scab.

Select tubers free from all signs of rot and as free as possible from scab and little hard lumps on the surface. Place them in a pile on the barn floor, sprinkle them thoroughly with water, and cover them with sacks and leaves for twenty-four hours. At the end of this time soak them for an



Hard black lumps (sclerotia) of Rhizoctonia on Potato.
(Original.)

hour and a half in a solution of corrosive sublimate of the strength of 4 ounces of corrosive sublimate to 25 gallons of water. In preparing the solution dissolve the corrosive sublimate in a little hot water and then add it to 25 gallons of cold water. Fill a barrel or trough with the potatoes, then add the solution until the potatoes are covered. Leave for the required time, then drain off the solution into another receptacle. After each lot of tubers has been treated add one-half ounce of corrosive sublimate and keep the volume of the solution constant by adding more water when necessary. After four lots of tubers have been treated the solution should be entirely renewed. After this treatment the usual precautions should be taken to prevent the tubers becoming re-infected.

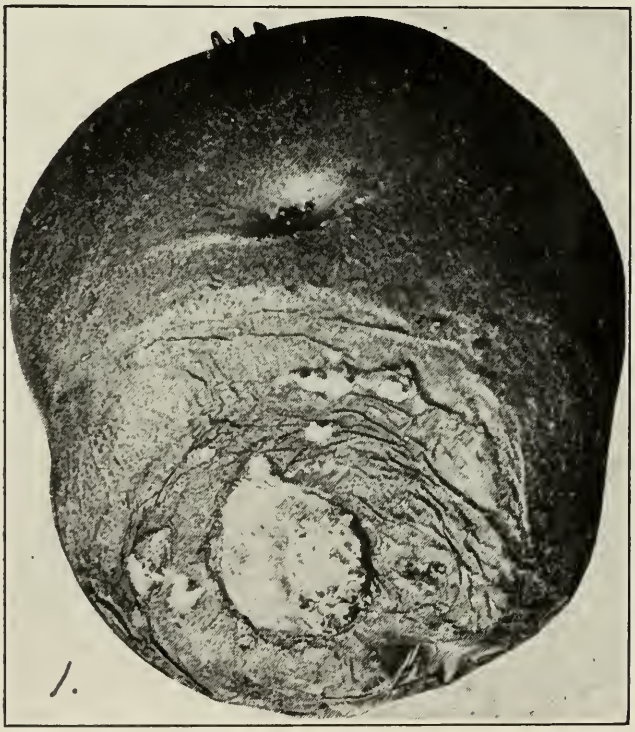
N.B.—Corrosive sublimate is a deadly poison and should be kept out of the way of children and stock. Potatoes disinfected with it should never be used for food for man or beast. (See note on corrosive sublimate, page 60).

FUSARIUM DRY ROT. This rot frequently develops in potatoes in storage late in the winter or early spring.

Symptoms. A firm, cheesy, dry rot develops in the tubers. This is often confined more or less to one end of the potato. The surface of the rotten portion is often covered with a white or pinkish fungus growth. Sometimes the whole potato shrivels and dries to a hard mass.

Cause. Various species of Fusarium are the chief cause of this trouble. Some of these gain entrance to the tuber if the skin is broken when the potatoes are being harvested, transported or stored.

Control. Handle the potatoes in such a way to eliminate bruising as much as possible.

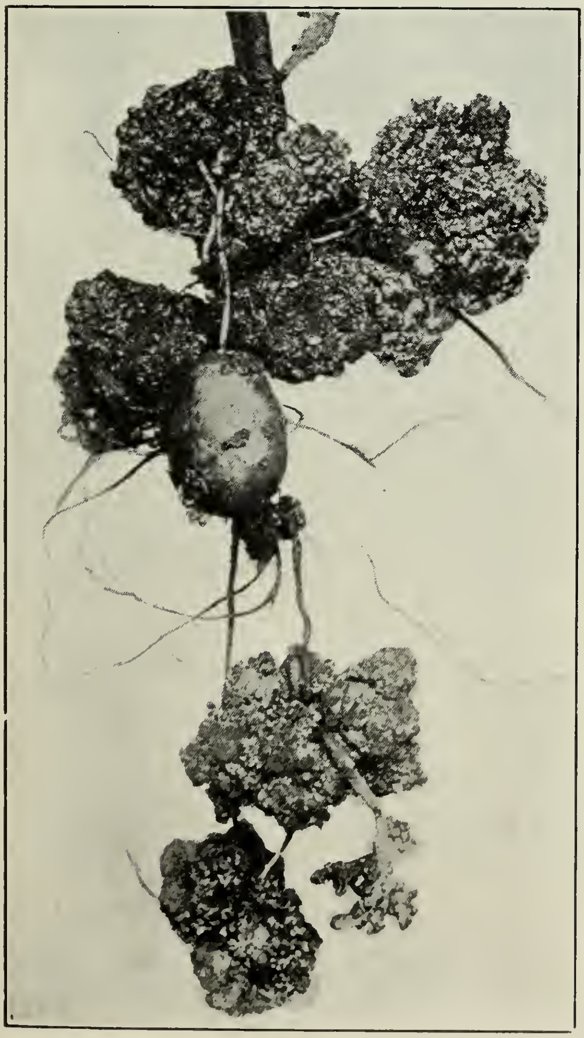


Fusarium Dry Rot of Potatoes. (Original.)

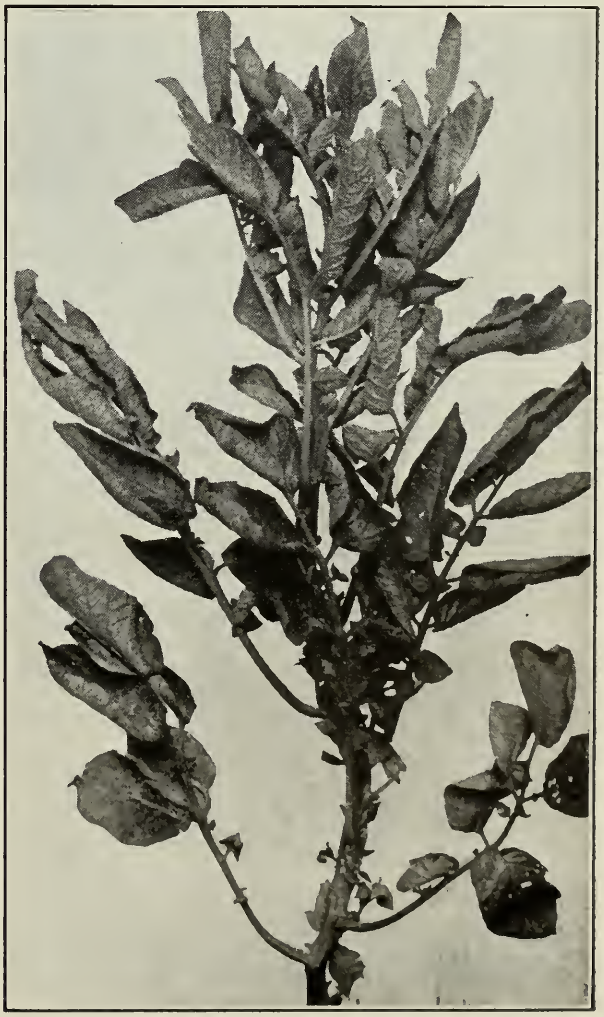
POTATO CANKER OR WART DISEASE OF POTATOES. This disease was found in Canada in 1912, but is not found in this country at the present time. This is owing to the fact that at its first appearance very prompt measures were taken to stamp it out, and probably to some extent to the fact that the two commercial varieties of potatoes which are so extensively grown in Ontario, namely Green Mountain and Irish Cobbler, are immune to this disease. It is a very serious disease to susceptible varieties of potatoes and it is important therefore that Ontario growers should be able to recognize it in order that they may report its presence promptly should it at any time appear in their crop.

Symptoms. Potato Canker is not usually observed until harvest time. Badly affected tubers are simply brownish-black masses of warty excrescences not in the least resembling potatoes. Tubers showing the early stages of the disease have some of the eyes slightly protruding and composed of simple or compound groups of small brown nodules. In the early stages this disease is very likely to be overlooked by the casual observer.

Cause. This disease is caused by the fungus Synchytrium endobioticum (Schilb.) Perc. This organism is carried over from season to season in the soil or in tubers. It may be carried into clean soil by drainage from infested soil, by farm implements and on the feet of men and animals.



Potato Canker. (After Gussow.)



Leaf Roll. (Photo by R. E. Stone.)

Planting infected tubers or tubers which have come in contact with diseased tubers is another way that this organism is spread. It is also spread in manure from animals to which diseased potatoes have been fed and by garbage into which warts or peelings from diseased tubers have been thrown.

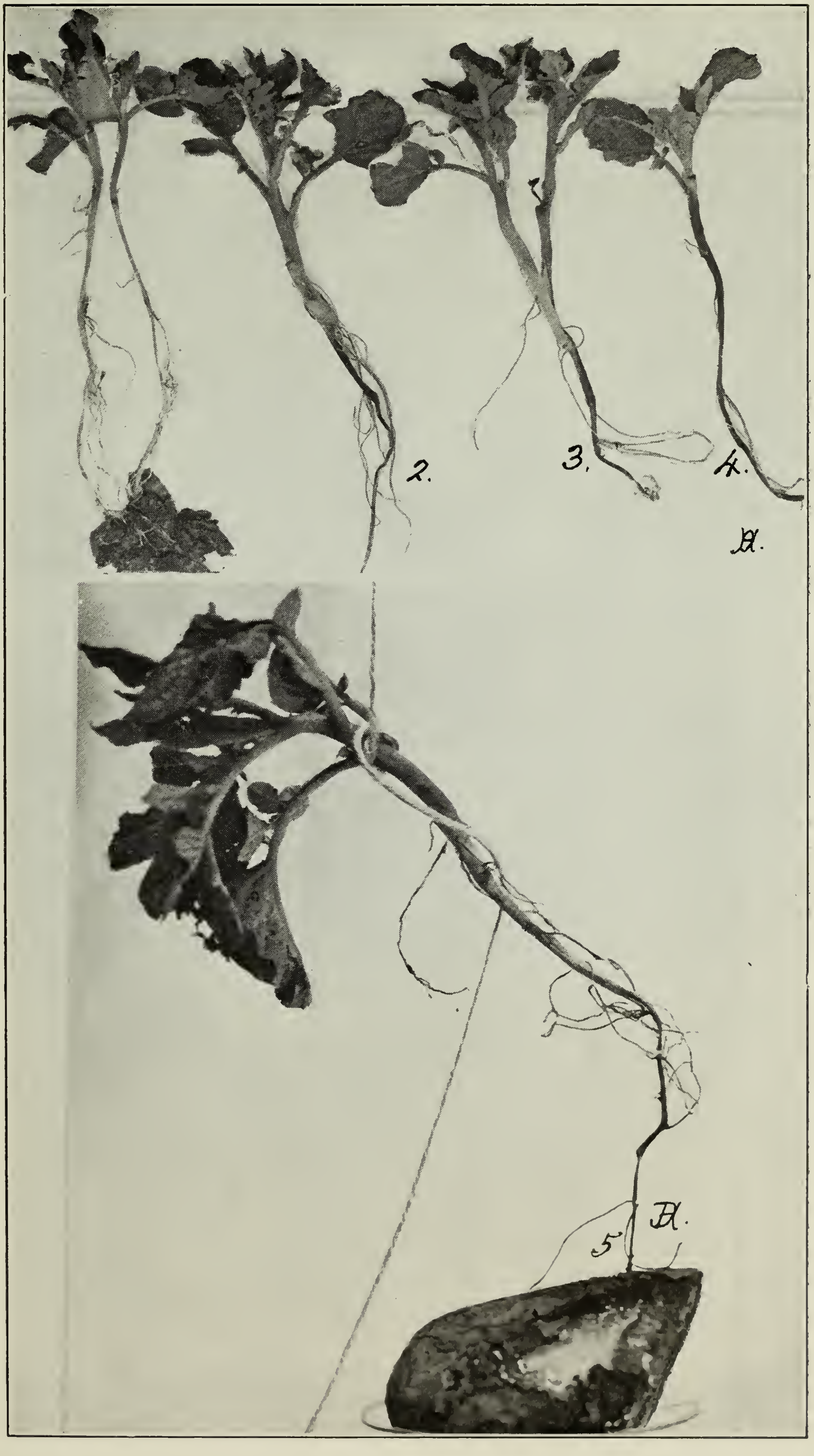
Control. Grow varieties of potatoes known to be immune to Potato Canker. In tests conducted in the United States the following varieties have been found to be immune: Green Mountain, Irish Cobbler, Early Petoskey, Peach Blow, McCormack and Burbank. Among those valuable varieties which were found to be very susceptible to Potato Canker are: Rural New Yorker, Early Rose and American Giant. If susceptible varieties of potatoes are grown be on the watch for this disease and if suspected potatoes are found send samples to the Dominion Botanist, Central Experimental Farm, Ottawa, or to the Botanical Department, Ontario Agricultural College, Guelph.

LEAF ROLL. In the past this disease has been very prevalent in the potato growing districts of Old Ontario. Since the use of certified seed potatoes has become general very much less leaf roll is seen in the Province. This disease may reduce the yield to a very marked extent.

Symptoms. These are very variable. Affected plants are always more or less dwarfed and in some varieties the leaves assume a characteristic upright, almost staring habit instead of drooping over in the normal way. This symptom is sometimes absent, the plants presenting instead a low-headed bushy appearance. When the crop is badly affected the poor growth of the foliage is very noticeable. It is practically never as green on affected plants as on healthy ones and occasionally on certain varieties it takes on a purplish or reddish colour at the tips and around the margins of the leaves. Rolling of the lower leaves is always associated with the disease. It is often rather inconspicuous and may not extend beyond the leaves lying close to the ground although it may affect the intermediate and even the topmost leaves. Marked rolling of the upper leaves however, is often seen on plants not affected with Leaf Roll. The rolled leaves of plants affected with this disease begin to die early. The harsh leathery texture of such leaves is a constant symptom. This point may be tested by feeling them with the fingers. The tubers of affected plants are small and are borne generally on very short tuber branches (stolons) or even attached in a cluster to the stem.

Cause. This is one of the virus diseases. The virus can be transmitted by transferring the sap from affected to healthy plants. Aphids or plant lice have been shown to be the chief carriers of the virus although it is probable that they are not the only carriers. The disease does not live over winter in the soil unless tubers that might produce volunteer plants are left in the field at digging time. Leaf Roll is transmitted chiefly through the "seed." Tubers from affected plants almost always produce diseased plants.

Control. The most important means of control is the use of healthy "seed." The man who is growing potatoes for table stock can avoid serious loss from Leaf Roll by purchasing from time to time certified seed potatoes. Certified seed potatoes should be planted at some distance from other potatoes in order to prevent leaf roll being carried to them.



Black Leg of Potato. (Original.)

and not so noticeable in others. The stalks of diseased plants are often more bare near the ground than those of healthy ones, partly because the affected foliage does not spread out and droop down normally and partly because the lower leaves sometimes fall off in the last stages of severe attacks. The symptoms of Mosaic are best detected on a cloudy day or when the plants are in the shade. Sometimes the plants are much stunted and have very strongly wrinkled or rugose leaves. This form of the disease is very conspicuous and is often called Curly Dwarf. Although the yield may be reduced the individual tubers from a diseased plant may be as large and appear as perfect as those from a normal one.

Cause. This is another virus disease. Aphids or plant lice are known to be the carriers of the virus from diseased to healthy plants. The pink and green aphid, one of those which is often found on potatoes, has for its winter host the wild and cultivated roses. In the spring the aphid leaves the roses and goes to potatoes and many other plants. It is very likely that the leaf hopper and other insects may also act as carriers of the virus. It is known that the virus may be transmitted by bruising diseased leaves and then rubbing the sap into healthy leaves or in any way by which sap is transferred. Like Leaf Roll, Mosaic is transmitted through the "seed" and is spread very largely by the use of "seed" from diseased plants.

Control. The control measures for Mosaic are the same as for Leaf Roll (See page 42).

BLACKLEG AND BACTERIAL SOFT ROT OF POTATOES

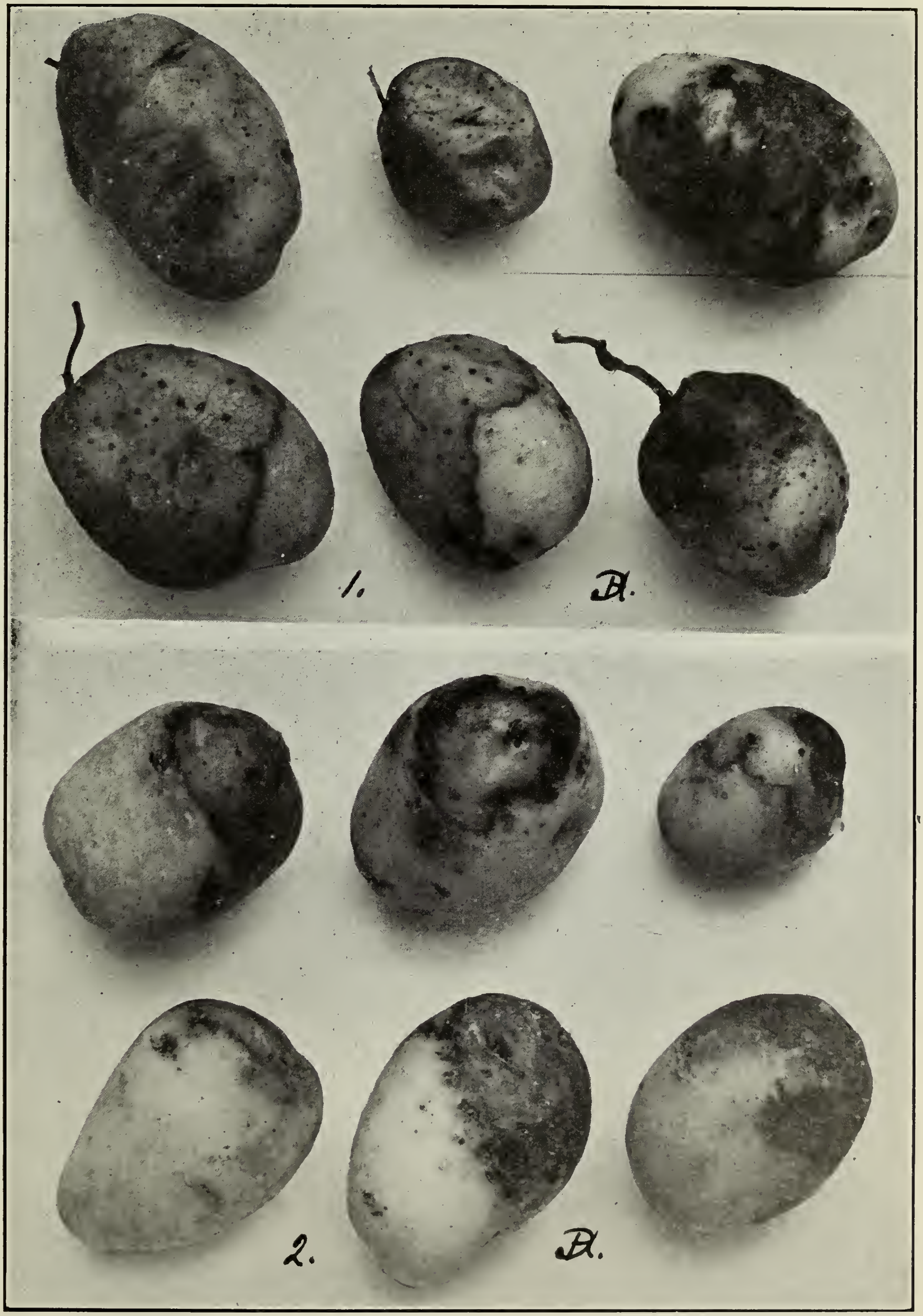
(*Erwinia atroseptica*) *van Hall, S.A.B.*

This disease is of fairly common occurrence and in wet seasons is apt to cause considerable loss in the potato crop.

Symptoms. Foliage and Stems. The tops of such potato plants as are affected with blackleg lose their bright green colour, which fades away to a brownish or dirty yellowish green, and present a general drooping or wilted appearance. The leaves have their edges turned upward or inward, and are limp and flaccid to the touch, contrasting in this last particular with plants suffering from "leaf roll", in which case the curled leaves are harsh and brittle to the touch.

The lower part of the stems of such plants show a dark brown or black discolouration, hence the name blackleg. This discolouration is more often found below the soil surface from the seed tuber up, but may extend upwards for an inch or two above the soil. In many cases such discoloured tissue will be rotting with a soft, slimy rot, soon followed by a shrinkage of the affected area, after which the top falls over on to the soil and rots away. An examination of the seed tuber from which the plant has grown will usually show it to have rotted away with a soft, slimy, wet rot, often nothing but the skin being left. The soil underneath such a rotted seed tuber frequently appears as though it had been wet puddled, owing to rapid extraction of water from the seed tuber during the rotting process.

The disease usually develops in the young plant from an infected seed tuber. In some cases sprouts from such a tuber will scarcely reach the surface of the ground before they die from the rot. In other cases sprouts will reach the surface, develop roots and produce a top before signs of the disease are visible. Sometimes one or more stems of a plant will be affected with the disease and die off, while other stems of the same plant may reach



Potato Tubers, showing Bacterial Soft Rot in various stages of development, some tubers entirely rotted, others only partially affected. (Original).

1. Six tubers that contracted the disease directly through the stem from the parent plant.
2. Six tubers that contracted the disease at the eye end from coming in contact with other diseased tubers.

maturity and produce tubers. In such cases there is a strong probability of the tubers becoming infected with the characteristic soft wet rot. Particularly is this the case in wet seasons. In such cases the disease passes from the infected parts underground along the tuber stems and thus gains entrance to the tubers. Other tubers in close contact with the diseased ones may get the disease from such close contact.

Tubers. In tubers where the disease is not far advanced the tuber may at first sight appear sound, but on closer examination, particularly if the specimen be washed with clear water, the skin over a diseased area will appear slightly discoloured, indicating a water-soaked condition of the tissue beneath. The discolouration will be more noticeable around the edge of the diseased portion, showing up as a reddish brown line. If pressure with thumb or finger be applied to such a discoloured area the skin slips or peels off fairly readily and the tissue immediately beneath is found to be soft rotted, sometimes only to a very slight depth, at other times to a much greater depth, depending on the extent to which the disease has developed. When the rot is far advanced in the tuber the great bulk of the tissue will be soft and mushy. On breaking the skin the pulpy interior oozes out, often showing gas bubbles and giving off an offensive odour. On exposure to the air the soft pulp darkens in colour. Sometimes the interior of a diseased tuber is completely rotted to a soft pulp, but the skin, being intact, keeps its rotundity and smoothness as a result of the gas inside the pulp. Slight pressure of such a tuber causes it to collapse.

Cause. The bacteria which cause this disease gain entrance to the growing plant at the bottom of the stem from diseased seed tubers. As they grow and multiply they produce an enzyme (digestive substance) which dissolves the middle lamellae (cement material) which binds the cells together in healthy tissue. As the solution of this binding substance takes place the tissue breaks down into the characteristic soft, wet rot.

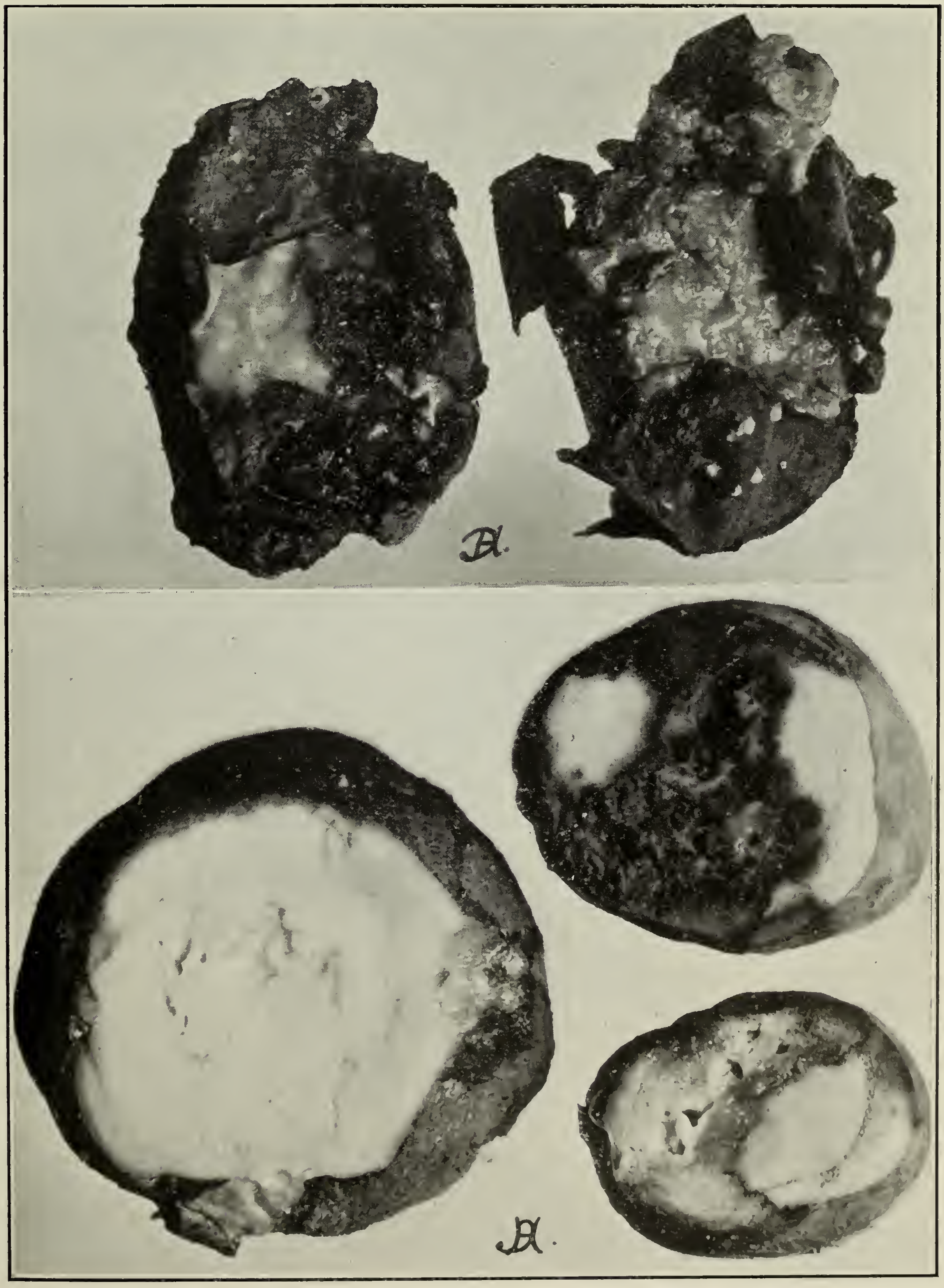
Control. (1) Do not plant seed tubers that show any signs of disease. It has been shown by one investigator that the seed corn maggot (*Phorbia fusiceps*) will inoculate healthy seed tubers after they have been planted, with the bacteria that cause the disease. His theory is that the adult flies of this maggot will feed on diseased potatoes and so get contaminated with the bacteria. They lay their eggs in cracks of the soil near planted seed tubers. The surface of the eggs are contaminated with the bacteria at the time they are deposited. When the eggs are hatched the maggots get contaminated from the eggs, and thus, when they feed on the seed potatoes, inoculation of the same takes place.

(2) Growing plants that show signs of blackleg should be carefully removed from the crop and burned.

(3) In harvesting potatoes from a crop in which the disease has occurred, care should be taken to discard all tubers that show signs of rot. Unfortunately, only those tubers in which the disease is fairly well advanced are readily noticed as being diseased. A considerable proportion may have the disease so lightly established as not to be noticed without very careful observation. If such tubers are stored in bulk in a pit, or in bags in a cellar, the rot is sure to spread. If such tubers are allowed to dry out, the rot may be checked in many cases. It is in such tubers that the disease is carried over for next season. Consequently tubers that have been obtained from a crop in which blackleg has been present should never be used for seed purposes. They should be sold for immediate consumption.

(4) Dipping seed potatoes in corrosive sublimate 1-1000, at time of cutting, aids in preventing the disease.

(5) Land on which potatoes are grown should be well drained.



Tubers in advanced stages of the Bacterial Soft Rot, taken directly from the field. (Original).

Mosaic. This disease has been observed in many fields in Ontario. When it is severe there is a very noticeable reduction in the crop.

Symptoms. The foliage of plants affected with Mosaic is somewhat wrinkled or corrugated and mottled with faint, light green or yellowish spots. These symptoms vary considerably, being well marked in some cases

Tip-Burn or Hopper-Burn of Potatoes. This trouble is very frequently seen in abundance in Ontario in hot dry summers. When serious it causes a marked reduction in the yield.

Symptoms. There is at first a slight wilting and rolling inwards of the edges of the leaves which soon turn brown. When the trouble is serious this browning and curling may extend to the midrib or near it over a considerable portion of the leaves.

Cause. There are two types of injury, (1) true tip-burn which is the result of hot sunshine and warm dry winds causing an excessive loss of water from the leaf tissue. (2) hopper-burn caused by apple leaf hoppers (Empoasca mali) puncturing the leaf veins and sucking the juice. This insect may often be seen rising in swarms as one walks through an infested field.

Control. Keep the soil rich in humus and see that the potatoes are repeatedly and thoroughly cultivated to conserve moisture. Spray with Bordeaux mixture as for Late Blight and Rot. Spraying has a direct effect on the true tip-burn as well as acting as a repellent for leaf hoppers.

TOMATOES

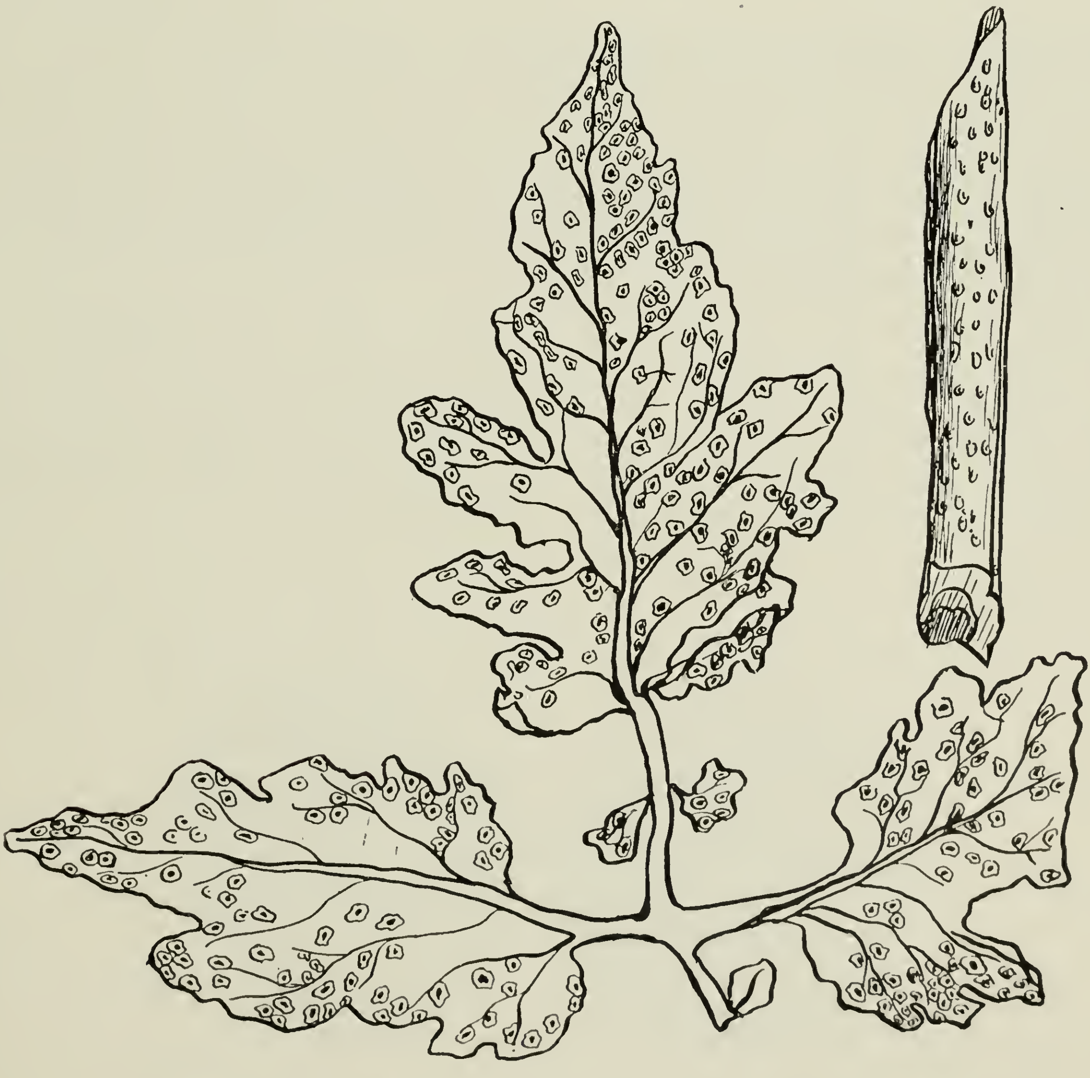
Blight or Leaf Spot of Tomato. This is the commonest disease of tomatoes grown in the open in Ontario. In certain sections of the Province it causes serious loss to tomato growers by destroying the foliage early in the season, with the result that the fruit does not ripen properly or is sunscalded. It causes most damage in seasons of high temperature and high humidity.

Symptoms. Blight or Leaf Spot is easily recognized by the small, grayish-brown angular spots containing minute black specks which appear on the leaves and stems. Badly spotted leaves wither and dry up. The lower leaves are first affected and the disease spreads upwards, often completely destroying all the foliage of the plants except the new growth near the tips. Sometimes small spots occur on the fruit also.

Cause. The fungus which causes this disease is Septoria lycopersici Speg. This fungus produces countless spores in little black fruiting bodies (pycnidia) in the diseased spots on the leaves. During periods of high temperature and excessive humidity these spores are liberated and carried to neighbouring leaves or plants by insects, wind, rain and the hands and clothing of pickers. This fungus is carried over the winter in the diseased leaves and stems which drop to the ground, and in the remains of certain weeds which are also attacked by it.

Control. This disease frequently starts in the seed bed. In order to prevent this the following precautions should be taken. Any wood around the seed bed should be drenched with a solution of formalin (1 pint to 20 gallons of water). If Leaf Spot has been prevalent in former years the soil in the seed bed should be renewed or sterilized with steam or formalin. The plants in the seed bed should be sprayed at least twice with Bordeaux of the strength of 3 pounds of copper sulphate, 6 pounds of hydrated lime and 40 gallons of water, to which has been added resin fish oil soap as a sticker. The first spraying should be given when the plants are three or four weeks old and the second about a week before they are set out in the field.

The two sprayings given before the plants are set out in the field should be all that are necessary to control the disease in early tomatoes. Late tomatoes should receive two more sprayings after they are set out in the field with Bordeaux and resin fish oil soap. The first should be given three or four days after the plants are set and the second in ten days or two weeks time. Ordinary Bordeaux does not adhere very well to the surface of tomato foliage and it has been found necessary to add resin fish oil soap as a sticker in order to secure the best results from spraying. (See directions concerning resin fish oil soap, page 60).



Leaf Spot of Tomato. (Attacked leaves and stem).
(From Ohio Bulletin 73).

If Leaf Spot is very troublesome a rotation of crops should be followed so that tomatoes are not grown upon the same piece of ground oftener than once in three or four years. When such a rotation of crops is followed it is much easier to keep Leaf Spot under control.

BLACK ROT, RIPE ROT, TARGET SPOT. This is a very common disease of tomatoes in Ontario. In wet seasons it causes very serious losses to the growers of canning tomatoes in Eastern Ontario.

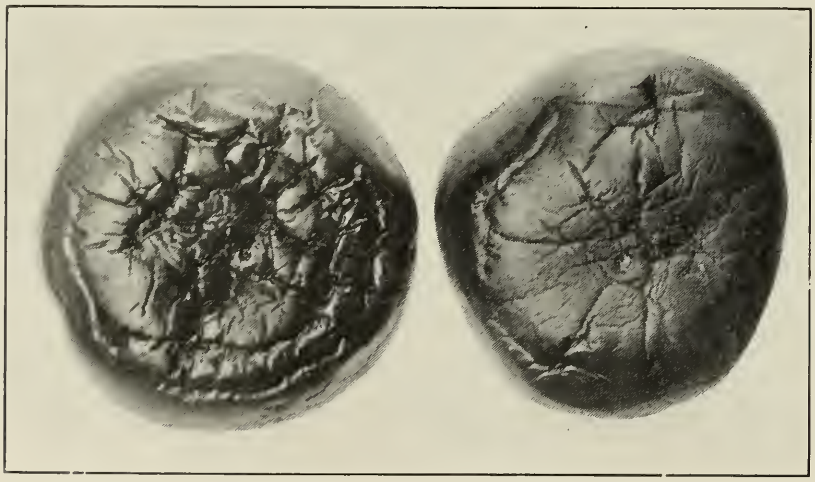
Symptoms. On the fruits are seen dark brown or black sunken rotten spots. Some of these may be an inch in diameter. The discolorations from the rot usually extend to the centre of the fruit rendering it unfit for canning purposes. On the leaves may be observed somewhat circular, dark brown spots which are sometimes one-half an inch in diameter. They are readily recognized by the peculiar ring-like or target-like markings, hence the name "Target Spot". The spotting of the leaves is of comparatively little importance. It is the rot on the fruit that causes the loss.

Cause. The fungus Macrosporium solani E. & M. which causes Early Blight of potatoes is also responsible for this disease. The life history of this fungus is described under the cause of Early Blight of potatoes (page 36).

Control. The directions given for the control of Leaf Spot of tomato apply also to the control of this disease.

BLOSSOM END ROT OF TOMATOES. This trouble is very common in Ontario both in tomatoes grown outdoors and under glass. It is most abundant outside in seasons when periods of hot dry weather alternate with those of heavy rainfalls.

Symptoms. The trouble appears usually when the first fruits are about half grown or a little later. Slightly sunken water-soaked areas are seen near the tip of the fruit. These are at first lead colored or brownish but soon become lead-brown or black in color and of a leathery texture. Various fungi and bacteria may gain entrance through these injured spots and cause rot which may destroy the whole fruit.



Blossom End or Point Rot of Tomatoes. (Original).

Cause. It has been shown that this disease is not due to any organism. It is one of the so-called physiological diseases due to some condition within the plant itself probably induced by its environment. Improper fertilizers and irregularities in the water supply appear to be important factors in causing this trouble.

Control. Excessive amounts of organic fertilizers such as farmyard manure appear to have a marked effect in increasing this trouble. Avoid over-watering the plants especially in the early stages of their development. The water supply of tomatoes grown under glass should be even and regular. Some growers claim to reduce the amount of this trouble by mulching diseased plants. Others consider that repeated good cultivation to conserve the moisture supply is the most effective preventive measure.

TOMATO MOSAIC. This disease is frequently seen in Ontario both in the field and under glass. It is not an uncommon thing to see fifty per cent. or more of the plants in a greenhouse affected by Mosaic.

Symptoms. The leaves of affected plants may be mottled with light green or yellow or they may be dwarfed and have a peculiar fern-like appearance. Sometimes the leaf segments are so narrow and slender as to appear almost thread-like. This form of the disease is referred to as Shoestring Mosaic.

Cause. This is a virus disease, that is, the juice of diseased plants contains something which when transferred to healthy plants causes them to be diseased. It is known to be transmitted from plant to plant by plant lice or sucking insects, and by workmen pruning and tying plants in the greenhouse or field. The virus which causes Mosaic lives over the winter in old tomato plants in the greenhouse and in the roots of perennial weeds which are closely related to the tomato such as Ground Cherry (Physalis spp.) The same virus also causes Mosaic of tobacco, pepper and petunia and potatoe.

Control. It is not advisable to use tomato plants from a seed bed in which Mosaic has developed. All weeds belonging to the potato family such as Ground Cherry, Horse-nettle and Black Nightshade growing in the neighbourhood of the greenhouse or tomato field should be destroyed. So far as is possible control aphids by spraying or fumigation. In working among tomatoes the hands should be washed repeatedly with soap if there is any possibility that diseased plants are being handled. If potatoes, petunias, egg-plants, peppers and other susceptible crops are grown near the tomatoes, Mosaic may spread from these to the tomatoes.

STREAK OR WINTER BLIGHT OF TOMATOES. This is one of the most troublesome diseases of greenhouse tomatoes in Ontario. It sometimes appears also in field tomatoes but seldom causes severe injury.

Symptoms. The first indications of Streak are a curling and twisting of the upper leaves and younger portions of the stems. Brown sunken streaks appear in the young vigorous growing stems and these increase in width until the whole upper part of the stem may become brown. At first the browning appears to be on the surface only but soon becomes deeper seated and in bad cases involves the woody ring. At the same time these streaks appear on the stem, brown angular spots appear on the leaves between the veins and these brown spots may increase in size until the whole leaf is involved. Fruit sets very sparingly, often none on the first two or three trusses. The fruits that do set are commonly scabby, deformed and of poor flavor and color. Large soft, sappy vigorous growing plants are those most subject to this trouble. Streak is frequently associated with Mosaic.

Cause. The cause of this disease has not been definitely proven. In England it is considered that Bacillus latheri, the organism that causes Streak of sweet peas is also the parasite associated with Streak of tomatoes. Experiments conducted in the United States and in Canada indicate that it is probably a virus disease. The early investigational work conducted at the college here lead to the conclusion that Streak was probably the result of an unbalanced fertilizer. All investigators appear to agree that an oversupply of nitrogenous fertilizers causes the disease to appear in epidemic form. Poor ventilation, irregular watering and fluctuating temperatures are favorable for the production of Streak.

Control. Dr. Stone of the Botanical Department, Ontario Agricultural College, has been carrying on for a number of years investigations concerning the control of Streak, and as a result of these investigations he makes the following recommendations: Avoid the use of too much manure or nitrogen containing fertilizers such as ammonium sulphate and sodium nitrate. Add acid phosphate or boneflower (3 ounces per plant) and potassium sulphate (¼ ounce per plant) either before transplanting or just after the blossoms appear. Avoid over-watering and then allowing the plants to become too dry. Keep the plants growing evenly by keeping the temperature uniform and watering at frequent intervals but not too much at any one time Do not attempt to force tomato plants that have been checked.

LEAF MOULD. This disease is frequently met with in greenhouse crops of tomatoes and occurs to a lesser degree in the field.

Symptoms. The leaves, especially the lower surface become covered by an olive-brown mouldy or felt-like fungus growth. Affected leaves turn yellow or brown and in severe cases shrivel and die.

Cause. This disease is caused by the fungus Cladosporium fulvum Cke. This fungus is carried over from season to season in old diseased leaves in the soil of the greenhouse. It thrives best in a humid atmosphere and is very susceptible to temperature. The spores germinate best at a temperature of from 65° to 75°F. They will not germinate in a relatively dry atmosphere. Cloudy days increase the virulency of this organism.

Control. Proper ventilation of the greenhouse is the best preventive. The disease will not develop if moisture does not condense upon the leaves. This can be prevented by opening the ventilators and providing a little more heat if necessary. The watering of the plants is best done in the morning of dry sunny days. Bordeaux mixture if applied very heavily and under high pressure at five day intervals will hold the disease in check if the first application is made before the disease appears. This is seldom necessary if the greenhouse is well ventilated and the plants properly watered. Some growers recommend fumigating each house with sulphur before the plants are put in. Such fumigation should never be attempted after the plants are set into the beds.

DAMPING OFF

The seedlings of many plants are liable to be affected by this trouble. It occurs mostly in the seed bed where plants are growing in a crowded condition. It is seldom found in the open field. It is also a common disease in greenhouses where relatively high humidity is maintained and where the plants are not exposed to sunshine and free circulation of air.

Symptoms. The stems near the ground are girdled by brown lesions which cause the plants to fall over and ultimately die.

Cause. Rhizoctonia, species of Fusarium and Pythium de Baryanum are among the commonest fungi causing this trouble.

Control. If serious Damping Off has occurred at some previous time the soil should not be used again, or if used it should be sterilized with steam or formalin. (See page 60). Take the following precautions to prevent the accumulation of too much moisture in the surface soil and reduce the relative humidity of the air about the plants; (1) stir the upper layers of the soil frequently; (2) provide good ventilation so that there is free circulation of air about the plants and expose them as much as possible to sunshine; (3) water the plants in the morning rather than in the late afternoon or evening; (4) sprinkle layer of dry sand over the surface of the soil; (5) avoid too thick sowing; (6) avoid over-watering.

BACTERIAL SOFT ROT OF VEGETABLES

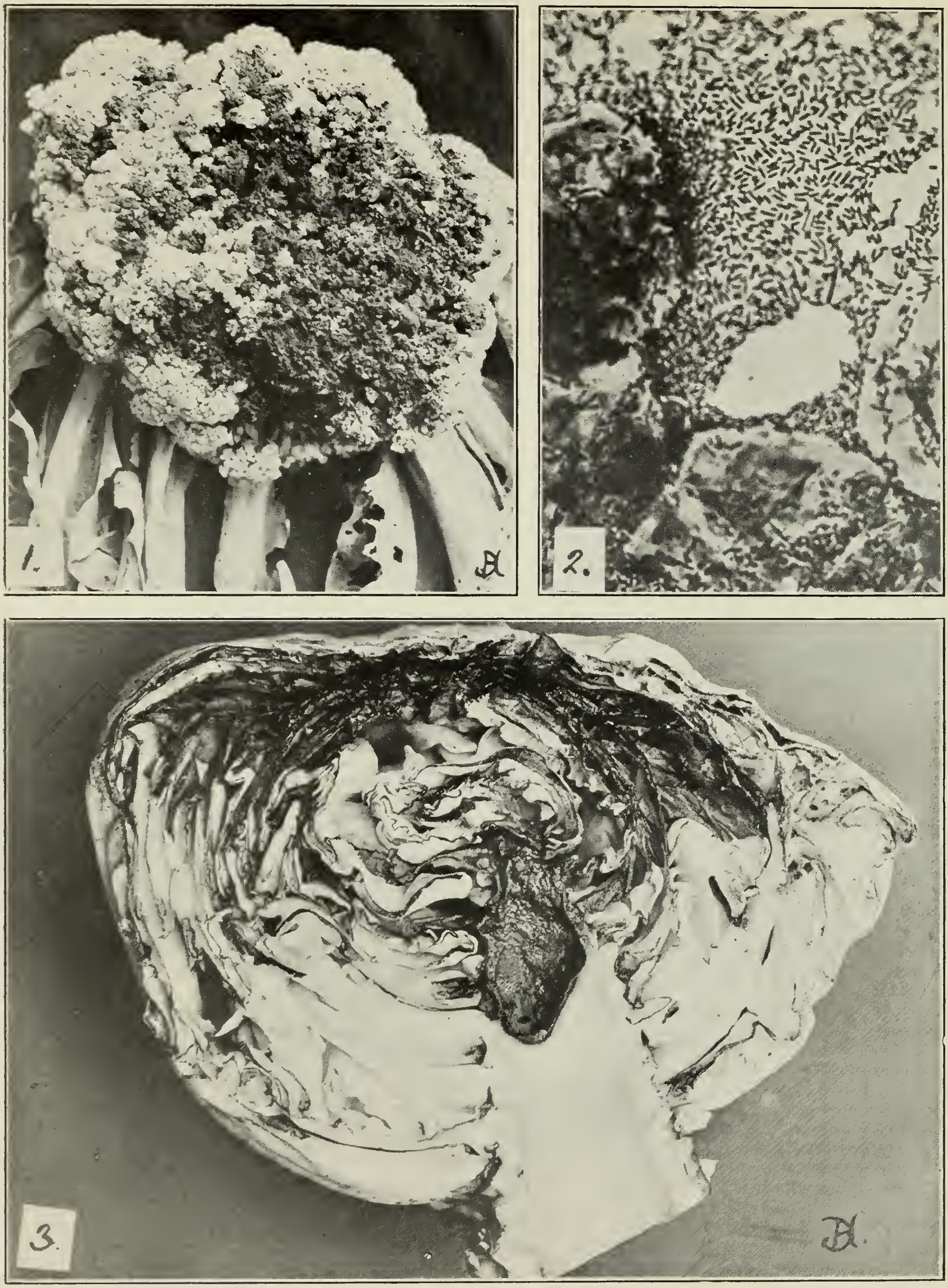
(*Erwinia caratovora*) *L. R. Jones, S.A.B.*

Bacterial soft rot is a disease liable to attack fleshy vegetables and flowers, particularly carrots, cauliflower, turnips, celery, tomatoes, potatoes, German iris and calla lily, and in a lesser degree, onions, asparagus, salsify, sugar beet, mangel, musk melons and some others. Occasionally the disease results in heavy losses to the grower of these crops.

Symptoms. As the name signifies, the disease results in a soft, wet rot of the plant attacked. The rotted portion of the plant is darker in colour than the rest of the plant. The colour of the diseased part varies from a light, reddish-brown to a very dark brown in the case of white or creamy fleshed plants, such as cauliflower, turnips or heart of celery, and a very dark green, almost black, in case of the green tissues which are attacked. The diseased tissue is very soft and mushy, and frequently has a strong and offensive odour. There is a clear line of demarcation between the diseased and healthy tissues, the disease inducing complete destruction of the tissue as it advances from the point of inoculation.

In cauliflower the disease is found often in the "flower" than in the leaves or stem; the latter parts, however, are also subject to attack.

The disease in the "flower" is very easily noticed, the normal colour of the "flower" being white or creamy and that of the diseased portion light to dark brown, and very soft; and having an offensive odour. The writer has noticed a number of times dark brown areas varying in size, which looked at first sight like soft rotted areas, but which on investigation proved to be discolourations due to excreta of cabbage caterpillars which had been feeding on the leaves overhanging the "flower". In such cases the tissue im-



Bacterial Soft Rot of Cauliflower and Cabbage. (Original.)

1. Bacterial soft rot of cauliflower, natural infection; specimen taken direct from garden.
2. *Erw. caratovora*, the vegetable soft rot bacillus seen between cells of broken-down, rotting cauliflower. (x 1000 di.)
3. Bacterial soft rot of cabbage. Artificial stab inoculation of a pure culture of *Erw. caratovora* in healthy cabbage. Photo taken twenty days after inoculation.

mediately below the surface of the discoloured area is not softened as it is in the case of the rot, and the discolouration is only on the surface. Observation has shown, however, in a number of such cases, that the rot has later developed within such discoloured area, thus indicating that in all probability the caterpillar had previously been feeding on a rotted plant and all the bacilli in the portion consumed had not been killed in the process of digestion, but had passed through the alimentary tract of the caterpillar with the excreta; or that the mouth parts and feet of the caterpillar had been contaminated from a diseased plant, and on crawling over the surface of the healthy plant had inoculated it.

In the stem the disease results in a complete softening of the interior, the softened tissue becoming a dirty grey in colour with strong odour. The disease may enter the stem from injury to the exterior caused by the breaking of leaves, or the biting of insects, slugs and caterpillars during cultivation, etc., and from the stem pass up into the "flower", or the stem may become so far rotted that the head will fall off. The stem may also become infected through the "flower".

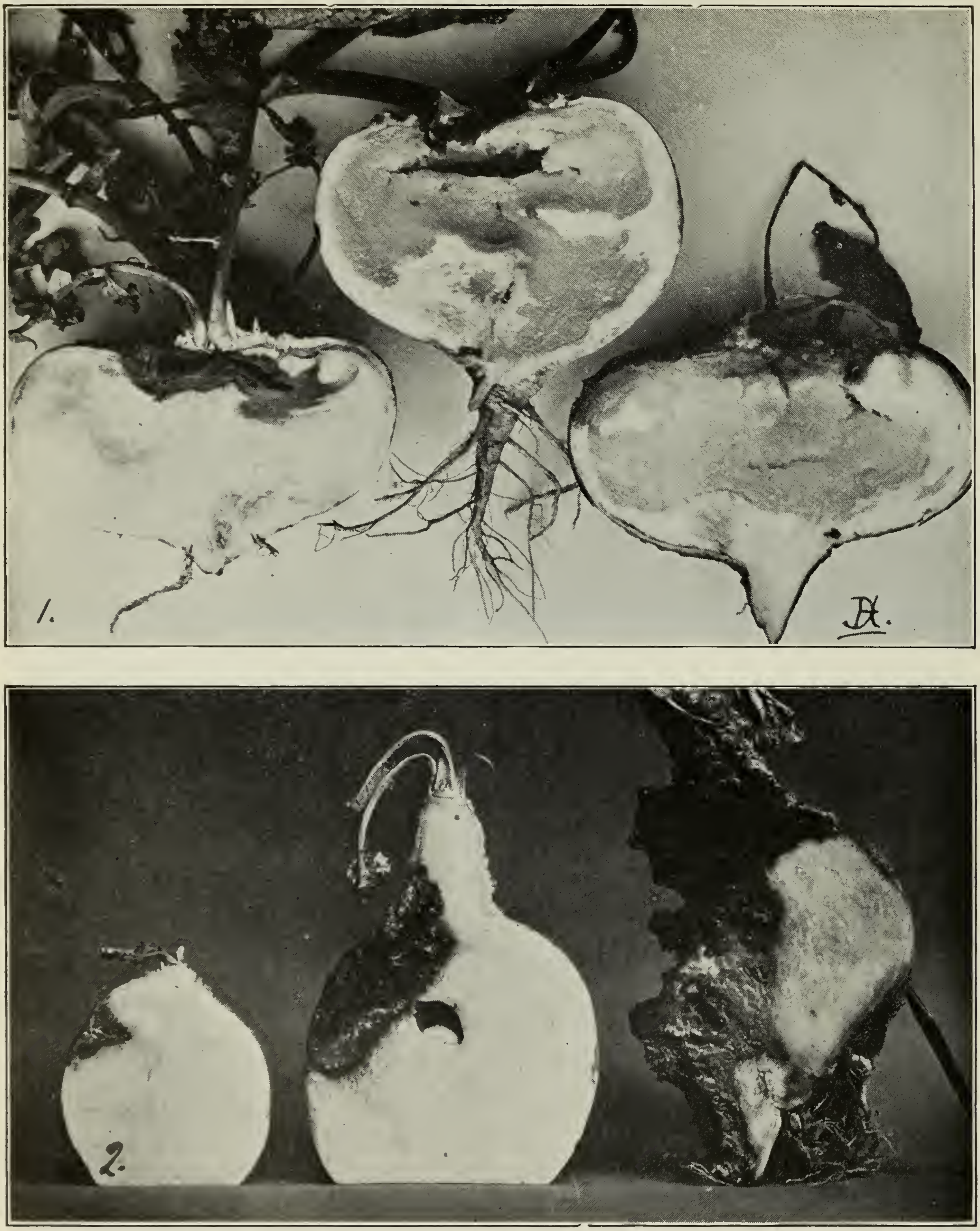
In the leaves the disease is more often found in the petiole or midrib rather than the blade. It appears as a dirty grey, softened area, which, when in the petiole, soon results in collapse of the leaf.

In *Turnip* the disease most frequently enters at or near the crown, through caterpillar or slug attack, or through injuries received during hoeing or cultivation. It softens or rots the leaf petioles at their base, causing them to fall over; and spreads slowly in dry weather, rapidly in wet weather, through the tissue of the root, inducing a brown coloured soft rot with strong odour.

In *Carrot* the disease enters and develops in much the same way as described for the turnip. It is more apt to spread rapidly through a crop that is thickly sown and not well thinned out, the shade produced by the heavy tops making ideal conditions by keeping the ground moist for the development of the disease when once it gains entrance, and harbouring slugs and caterpillars that spread the disease. Carrots which crack beneath the ground are liable to be attacked by the disease, the soft rot bacillus gaining entrance to the tissue through the cracked surface.

In *Celery* the disease is most often found starting at or near the tops of the young growth. The affected parts become dark brown and very soft and mushy. The parts so affected cease growing, the growing tips being destroyed, and the disease passes down the stem, completely rotting the tissue as it progresses. If the disease starts below the end of the stem, the upper part soon topples over as a result of the softening of the part attacked. The disease spreads from plant to plant through the agency of slugs, caterpillars and insects, particularly the tarnished plant bug, and during the process of handling when cultivating and banking up. When the plants are stored away for winter use, if a plant having the disease is stored with the healthy plants the rot is liable to spread to the healthy specimens.

In *Tomatoes* the disease is very common during wet seasons. It is found most frequently in the fruits that are in contact with the soil after they have commenced to ripen. The bacillus will not readily penetrate through the unbroken skin of the tomato. But when a tomato is resting on the damp earth, that part of the skin in contact with the soil is frequently weakened, thus providing a means of access to the bacillus. This, however, is not the only means whereby the disease enters the fruit. Slugs are very partial to tomatoes just ripening. In their attack on the fruit



Bacterial Soft Rot of Turnip. (Original.)

1. Turnips direct from field badly affected with bacterial soft rot. Shaded areas were soft, pulpy and strong smelling. Evidently inoculated near the crown, probably through wounds made by slugs or caterpillars or during cultivation.

2. Soft-rotting turnips direct from field, in which the disease had been prevalent the previous year. These had evidently been inoculated from the soil through wounds made while hoeing or cultivating.

they eat through the skin, leaving the interior flesh exposed. This exposed surface is an ideal medium for the bacillus of soft rot to develop in. The writer has found many tomatoes, particularly in wet seasons when slugs are plentiful, that have contracted the disease in this way.

Cause. When the soft rot bacillus gets onto a freshly made wound, either small or large, in plants liable to the disease, it feeds on the plant juice which emerges on to the wounded surface, and on this it grows and rapidly multiplies. As it multiplies it produces pectinase, a cytolytic enzyme which dissolves the middle lamellae, the thin strip of tissue which lies between adjacent plant cells. The lamellae are quickly dissolved and form good food for the multiplying bacilli, which, as they multiply, pass along between the cells, filling the intercellular spaces and separating the cells from one another. The protoplasm within the plant cells is plasmolised, that is, it is made to shrink from contact with the cell walls and to contract into an irregular mass within the cell, by the action of the enzymes produced by the bacilli in the intercellular spaces. In this way the collapse of the tissue is brought about, and such tissue constitutes the rotted part of the plant.

Control. Spraying with fungicides, which is so effective in controlling the fungus diseases of plants, is of no avail with bacterial soft rot, as the bacteria which cause the disease act in the interior tissue rather than on the surface; hence the spray will not reach them.

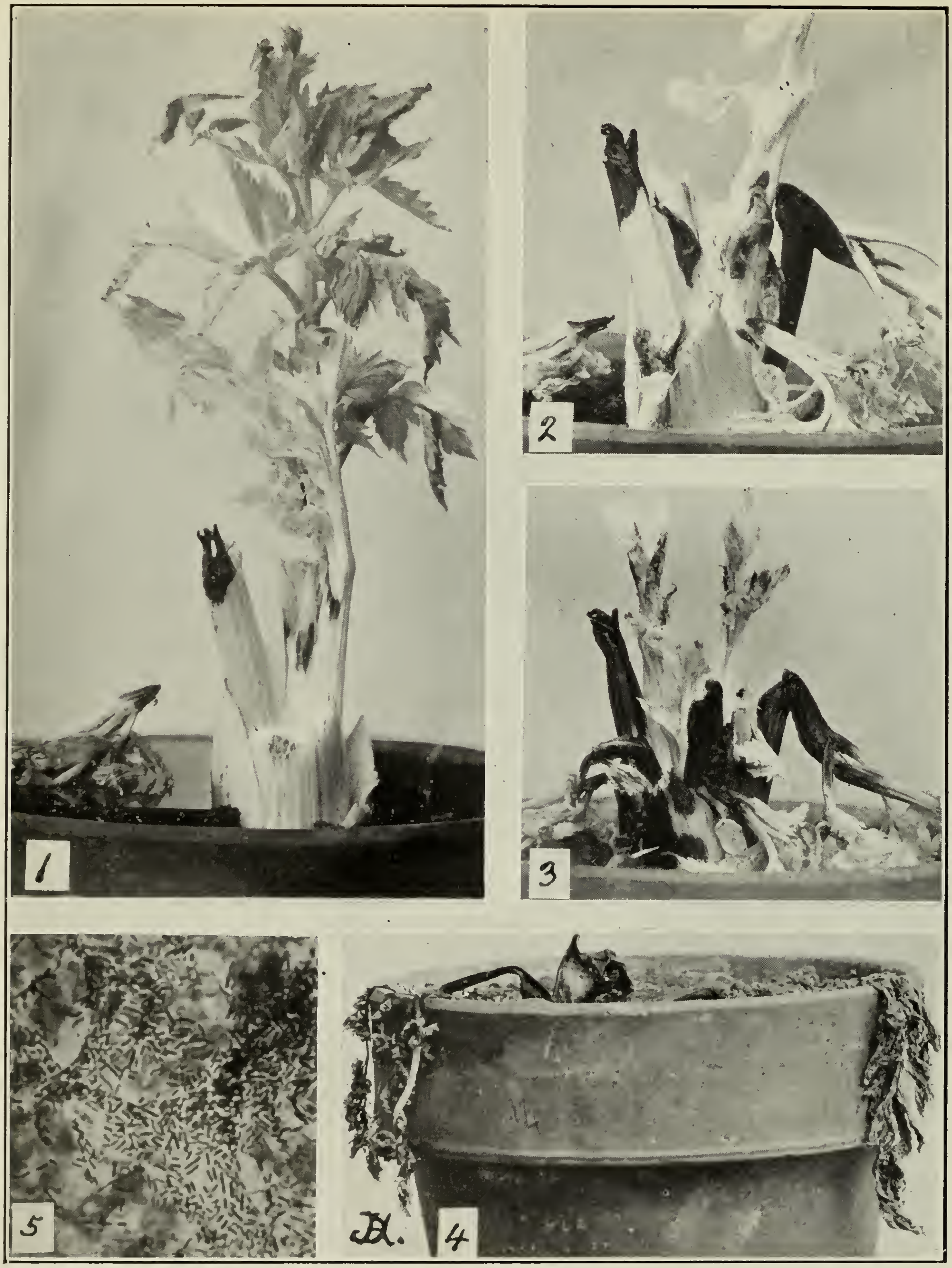
Spraying with insecticides is helpful indirectly, as it tends to keep in check the insects, slugs, caterpillars, etc., which are one of the most common means of spreading the disease from one plant to another.

As a rule the best method to adopt in dealing with a plant affected with bacterial soft rot, is to carefully remove and burn it. Insects, garden tools, etc., coming in contact with it will spread the disease to the plants with which they come in contact later.

Again, if affected plants are allowed to remain on the ground, they contaminate the soil with the organisms of the disease to such an extent as frequently to cause the disease to become established in the succeeding crop of any plants which are susceptible to the disease, but particularly plants of the same species.

Some time ago we received for examination a box of rotting, half-developed turnips, from a farmer who said that five per cent. of his crop were similarly affected. Upon enquiry we found that the affected ones were growing on soil on which turnips had been grown the year previous, and 25 to 30 per cent. of these having been affected with the same rot, had been allowed to remain on the ground at harvest time, and later were ploughed in. It was evident that the soft rot bacilli from the diseased turnips had remained alive in large numbers in the soil, and that many of the turnips of the subsequent crop had been inoculated with these bacteria during cultivation, and possibly by insect attack also, see page (56). The hoe or the teeth of the cultivator would get contaminated from the soil, and accidental wounding of a turnip with such an implement would result in the inoculation of the turnip with the germs of the disease.

Another man sent a head of celery for examination, which we found to be suffering from the bacterial soft rot in the young growing tips. In reply to our enquiries he sent word as follows: "I had celery on this ground two years ago, and the row that was where the rot is worst now was so bad then that I lost all; but only that row was affected. This year two rows had it, but one a great deal worse than the other. There were five rows in this patch, all planted about the same time. The healthy rows matured



Bacterial Soft Rot of Celery. (Original).

1. Artificial needle inoculation of pure culture of *Erw. caratovora* (isolated from rotting cauliflower) into the young and vigorous growth of celery. Five days after inoculation, kept at 25°C.
2. Same as Fig. 1, five days later.
3. Same as Fig. 1, ten days later.
4. Same as Fig. 1, three weeks after inoculation, showing complete collapse of plant.
5. B. carotovorous, the vegetable soft rot bacillus, between the cells of rotting celery tissue (x 1000 di.).

away ahead of the two which were diseased." Here it is evident that the soft rot bacteria had remained in the soil for two years, and that cultivation had spread the bacilli to some extent through the soil, as on the second occasion that celery was grown on that patch the plants in two rows developed the disease.

The writer had under observation a garden where turnips and carrots were both affected with the bacterial soft rot. The affected plants were not removed, but were dug in. The next year tomatoes were planted on the same ground. The disease did not develop in the growing plants, as care was taken not to wound them. However, about 60 per cent. of the fruit became affected before it was fully ripe. The affected specimens were either those that were in contact with the soil or had been bitten by slugs. The soft rot bacteria, which cannot penetrate through the sound skin of a tomato, found entrance through the slug bites or through the weakened skin that had been in contact with the soil.

Therefore, in order to prevent losses from bacterial soft rot of plants, remove and burn affected plants, or parts of plants, as soon as observed; be careful during cultivation not to wound plants, and keep caterpillars, slugs, biting and sucking insects in check. Affected plants should never be put on the compost heap or manure pile.

When harvesting and storing turnips, cauliflower, cabbage, celery, tomatoes or other vegetables from crops in which the disease has been present, great care should be taken not to include any specimen that shows the slightest appearance of the disease, or to smear the healthy specimen with the soft rotted parts of diseased specimens. If these precautions are neglected, the disease is liable to establish itself and spread more or less rapidly through the entire crop stored.

FUNGICIDES

Bordeaux Mixture

The principal fungicide used for vegetables is Bordeaux mixture. Lime sulphur, sulphur dust and copper-lime dust are also used with good results in the control of some diseases. Two formulae are commonly used in the preparation of Bordeaux for spraying vegetables. (1) Bluestone (copper sulphate) 3 pounds, hydrated lime or fresh stone lime 6 pounds, water 40 gallons; (2) bluestone 4 pounds, hydrated lime or fresh stone lime 8 pounds, water 40 gallons. Hydrated lime is the more convenient form to use as it does not require slaking. It can be purchased in 50 pound paper sacks and it is easily stored. If left exposed to the air however, it becomes worthless, so keep it in tightly fastened paper bags in a dry place.

To prepare Bordeaux mixture dissolve the bluestone, then nearly fill the tank with water. Add the proper amount of dissolved bluestone. Then while the engine is running add the hydrated lime or slaked stone lime and agitate the mixture for about 5 minutes. If a hand outfit is used agitate by pumping the liquid back upon itself for 5 minutes.

N.B.—The easiest way to dissolve bluestone in the crystal or lump form is to place 40 pounds of it in a bag and suspend this in a barrel containing 40 gallons of water, in such a way that the bottom of the bag sinks only three or four inches below the surface of the water. Leave over night and in the morning all will be dissolved. One gallon of the liquid will now contain one pound of bluestone. Small quantities can be dissolved readily by stirring in boiling water. Granulated bluestone dissolves very readily. If the desired amount is placed on a burlap screen over the opening in the tank it will dissolve while the water passes through it to fill the tank.

RESIN FISH OIL SOAP

Resin Fish Oil Soap is used with Bordeaux when a sticker is required to make the fungicide adhere better to the foliage. Three pounds of the soap are used with each 40 gallons of the Bordeaux. The soap is first mixed with water, using 1 gallon of water for each pound of soap. Hot water is preferable to cold water.

DUSTS

There are two classes of dusts, (1) finely ground sulphur, and (2) finely powdered bluestone combined with lime. Either of these can be secured with a poison added.

FORMALIN

Formalin is a clear liquid disinfectant. It is a 40 per cent. solution of formaldehyde gas in water. It is sold under the name of formalin and formaldehyde. It can be purchased in a drug store by the pound (16 ounces) or by the pint (20 ounces). It is important that the purchaser whatever name he buys it under, secures a solution of full strength, at least not less than 38 per cent. The solution should be kept in a well corked container and away from the frost. Formalin when diluted with water is not a dangerous poison although a weak solution will make the eyes smart and a strong solution will harden the skin temporarily.

CORROSIVE SUBLIMATE (MERCURIC CHLORIDE)

Corrosive sublimate may be obtained from any druggist. This is a deadly poison and should be so labeled and kept out of the way of children and stock. It is sold as a powder or in the form of tablets one of which dissolved in a pint of water gives a solution of the strength of 1 part by weight of corrosive sublimate to 1000 of water. It is not very readily soluble and hot water should be used to dissolve it. It corrodes metal and therefore should be mixed in wooden or earthen vessels. It is an excellent disinfectant but even in dilute solutions it is deadly poisonous. Great care therefore must be used in handling it. Potatoes disinfected with it should never be used as food for man or beast and vessels which have contained it should be thoroughly washed with hot water before they are used for any other purpose.

SOIL STERILIZATION

Many destructive insect and disease pests live over from crop to crop in the soil particularly in greenhouses. In order to get rid of these, soil sterilization becomes an important factor in the production of greenhouse crops. On many occasions the sterilizing is not thoroughly done, all parts of the soil may not be treated, or if treated, the soil is often re-infected with untreated soil being carried in on contaminated boots or on dirty tools either from the outside or from another greenhouse. If the soil becomes contaminated after sterilizing, the disease usually develops more rapidly than it would if no sterilizing had been done.

There are two methods of sterilizing soil, one by using formaldehyde or other soil disinfectants, and the other by using steam. The steaming is preferable as it is more thorough, gives better control of nematodes, and kills the weed seeds present. Steaming may also improve the condition of the soil by liberating certain salts that were in the ground but were not in an available form for the plant. In rare cases however, the crop following steaming is poorer than that previous to steaming as toxic substances which are harmful to growing crops may be liberated during the steaming. All seed beds and greenhouses are not equipped for sterilizing with steam and hence formaldehyde or some other disinfectant must be used.

FORMALIN

Use 1 pint of formaldehyde to 10 gallons water and by means of an ordinary sprinkling can apply this solution at the rate of 1 gallon to 1 sq. ft. of soil. If the soil will not absorb 1 gallon per sq. ft. make the solution stronger so as to get a pint of formalin on about 10 sq. ft. It may be necessary to use a pint of formalin to 6 gallons of water and then add the 6 gallons to 10 sq. ft. of soil.

Dig up the soil before treating and as soon as sufficiently dry after treating dig up again. Do not set out any plants or sow any seeds for at least 10 days after treating. If the soil is light and likely to dry out quickly, it is advisable to cover it for a day or two after treating, using canvas, boards, etc. Formalin treatment will not control nematodes but it may check them to some extent.

STEAM

Sterilizing the soil with steam is the best method that can be used. As stated above it not only destroys insects and disease organisms but it also kills weed seeds. The soil should be fairly loose when steamed and no large lumps. It should not be too wet as it requires much more heat to raise the temperature of wet soil. Various methods are used in steaming the soil some of which are as follows:

1. *Inverted pan.* For outside seed beds or for small greenhouses where there are no posts in the seed bed and where nematodes are not giving trouble, this method gives good results. A pan 6 ft. x 12 ft. and 8 inches deep made of No. 16 galvanized iron reinforced with angle iron is a convenient size of pan to use. In order to move the pan a handle or large ring should be attached to each corner of it. The pan should be held in place by stones or bags of sand and the soil banked around its edges. The steam should enter in such a manner that it is not forced directly into the soil at the point of entrance. The steam may enter at the central part of the pan and a "T" be fitted on the inside so as to force the steam each way, or the steam may enter at one end of the pan, or a bent pipe may be used which will pass underneath the edge of the pan and the open end come above the surface of the soil underneath the pan. The pan is connected to the boiler by means of piping and heavy rubber hose. The boiler should have a capacity sufficient to discharge steam at 80 to 100 lbs. lbs. pressure and the pan left in position for 30 min. or longer. The steaming should be con-

tinued until a potato about 4 inches deep in the soil is cooked. When the pan is moved forward to a new position it should be placed so that it will slightly overlap the area already sterilized. It is advisable to cover the place that has been sterilized with a heavy canvas in order to retain the heat and secure better penetration. Care must also be taken when moving the pan that no dirt be carried from the unsterilized area to that which has been sterilized. A threshing engine that is in good condition may be used for sterilizing with the pan system.

2. *Steam harrow.* The steam harrow is shaped somewhat like an ordinary field harrow. It is composed of hollow iron cross pieces and hollow teeth about 8 inches in length. At the lower end of each tooth is a small hole to allow the steam to escape. The whole harrow is covered with a heavy canvas so as to prevent the escape of steam. The teeth are forced to their full depth into the soil and the steam is passed into the cross bars from an attached pipe and escapes at the point of the teeth. As most of the steam escapes up the side of the teeth and does not penetrate the soil to any great extent the steam harrow gives no better results than the inverted pan.

3. *Steam pipes.* A number of pipes having a diameter of 1½ or 2 inches are used. A row of holes ⅛″ diameter and 6″ apart is drilled along one side. These pipes are placed in the soil in parallel trenches with the holes on the underside and with one end connected with a cross pipe which is joined to the steam line. The trenches are then filled in and steam passed through the pipes. This method however, is not very satisfactory as the trenches have to be dug and the pipes changed before and after each steaming. If left in the soil the holes are likely to become plugged and the pipes rusted.

4. *Tile.* In the larger greenhouses and where nematodes cause trouble, steaming through tile is the most satisfactory method of soil sterilization. Parallel trenches are dug and 3 inch or 4 inch tile are laid so that the top of the tile will be about 12 to 15 inches below the surface of the soil. They should be deep enough so that when the soil is being dug up there is no danger of breaking the tile. The centres of the trenches may be from 18″ to 2′ apart, depending on the nature of the soil. If the soil is loose and open the tile may be placed deeper and a little further apart than in soil of a heavier type. The length of the rows of tile also depends to some extent on the capacity of the boiler to be used in steaming. Four or five or more short rows of tile may be connected at one end by a cross pipe and steam passed into all of these at the same time, or tile may be laid the length of the house and steam passed into only one or two rows at the same time. Where this is done steam may enter at the middle of the row and pass each way in the tile. Where a large boiler has been used satisfactory results have been obtained in houses 300 ft. long with steam entering the tile in the middle of the row going 150 ft. each way. However, it is better to have shorter rows of tile and a few rows connected with a cross pipe as the temperature of the soil rises at a more uniform rate throughout the area that is being steamed. When rows are long one end frequently heats up faster than the other, hence a loss of steam. Under certain conditions tile may be laid in rows running crosswise in the house rather than lengthwise.

In order that a thorough job of sterilizing may be done the outer rows of tile should be laid close to the side walls and the ends of the rows of tile should be brought close to the end walls. The tile may be connected to the steam line in different ways. When a few short rows are to be sterilized at once, a two or three inch pipe may be placed in the ground along the ends of the rows with a "T" at the end of each tile and a short piece of piping running into each tile. Another short piece of piping is fitted into the middle of this and extends to the surface of the ground where it can be conveniently coupled up with the steam line. When steaming is completed a cap may be screwed on this pipe to keep out the dirt. If the steaming is to be done through long individual rows of tile it is preferable to have the steam enter at the middle of the row and pass each way. This can be done by having a "T" arranged so that each end fits into the tile and the central part comes to the surface of the ground. When steaming is completed in one row a cap may be screwed on the end of the piping that comes to the surface of the ground and it can then be left for future use.

When the steam is passed through a row of tile 100 ft. or more in length the opposite end of the tile should be fitted with a small pipe coming to the surface of the soil. This should be left open until the steam begins to escape freely and then closed. This is particularly necessary in heavier types of soil in order to allow the cold air in the tile to escape and thus ensures a more even distribution of steam. In loose open soils the cold air seems to escape more easily and hence it is not so necessary to have the far end of the tile fitted with a small pipe.

Steam sterilizing by means of tile should be done during the summer months. Results are more satisfactory and it is a much greater saving on fuel than when done in winter months. If done during the winter months the soil should be covered with blankets, canvas, etc., otherwise it is difficult to heat the surface.

Steam may be carried from the boiler to the tile through pipes used for heating but usually it is more satisfactory to run a direct line using 2 or 2½ inch pipe, from the boiler to the tile. This pipe line may be connected with the piping in the soil by means of an ordinary union or by using a piece of heavy rubber hose.

When starting to steam one should have on hand one or two good thermometers that will stand a temperature of over 212°F (boiling point) and protected by a case so they can be inserted in the soil. Such thermometers are expensive but are necessary if one is to be sure of a thorough job and at the same time not waste time and fuel.

The length of time required to sterilize any soil depends on the capacity of the boiler and the area that is being sterilized. A boiler with 100 H.P. capacity and carrying 75 to 80 lbs. of steam should sterilize an area the width of two rows of tile 100 ft. long in two or three hours. The larger the area the longer it will take. If the steaming is continued for an hour or even less after the temperature of the soil between the tiles has reached 200°F, the results ought to be satisfactory.

Soil that is to be used for potting purposes may be sterilized either by making use of the inverted pan or by building a narrow box with pipes fitted along both sides. On the side of the pipes next the centre of the box should be holes ⅛″ diameter and about 6″ apart. The box may be filled with soil, a tight fitting lid put on and steam passed through the pipes.

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BULLETIN 346] [NOVEMBER 1929

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE
GUELPH, CANADA

Hardy Alfalfa

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In each of the last fifty-two years alfalfa has been grown in the experimental plots at the Ontario Agricultural College. During this long period the usefulness of the plant has been carefully investigated. Many varieties and strains have been imported from different countries and their adaptability for Ontario conditions carefully tested and studied. In each of thirty-four years co-operative tests with alfalfa have been conducted by the farmers of Ontario through the medium of the Ontario Agricultural and Experimental Union. The results both of the experiments at the College and the co-operative experiments over Ontario have been summarized and presented in three bulletins (1900, 1908 and 1920) and in numerous reports, leaflets and articles. The object of this Bulletin is to present in a clear and concise way the factors necessary for successfully growing alfalfa in Ontario.

The Hay Loader, an implement which makes possible the curing of alfalfa hay in windrows—a labor saver and a time saver.

Alfalfa is not a clover but it is a deep-rooted legume. It possesses a unique combination of characteristics. Alfalfa starts growth early in the spring, and continues throughout the summer and even into the late autumn. Its large yields of nutritious feed for farm stock, its palatability, its perennial habit of growth, and its beneficial influence on the soil are all factors which commend it highly. Its ability to use the free nitrogen of the atmosphere and the fertilizing elements of the sub-soil add to its value as a farm crop. Alfalfa usually produces three crops per annum in southern and two crops per annum in northern Ontario, and under favorable conditions it thrives several years without the necessity of re-seeding. It can be used in the green or dry condition or can be converted into silage either alone or in combination with corn. In some localities of the Province the first crop of the season is allowed to ripen for seed production and in other sections the second crop is used for this purpose. Alfalfa is commonly used in short rotations but is particularly suited for rotations of several years' duration. The crop leaves the soil in excellent condition for other crops which follow.

The alfalfa acreage in Ontario has increased rapidly during the last ten years. In 1929 there was a total area of 685,880 acres. The increased acreage is largely due to the more general use of hardy varieties and to the use of better methods of alfalfa production. Alfalfa is now grown successfully in many places where it was a failure in former years.

Alfalfa Yields

In alfalfa experiments conducted at the College over a period of thirty-one years, four crops were obtained in 1896, two crops in 1907, 1924, 1927 and in 1928, and three crops in each of the other twenty-six years. The average yield in tons per acre, per annum, of the green crop for the whole period was 9.86 from the first cutting; 5.01 from the second; and 2.96 from the third; and of cured hay it was 2.50 from the first cutting; 1.31 from the second; and .76 from the third. The total average yield for the thirty-one year period was 17.89 tons of green crop and 4.59 tons of hay per acre per annum. The yield of alfalfa hay per acre amounted to over 6 tons in each of three years; between 5 and 6 tons in each of 10 years; and between 4 and 5 tons in each of 10 years and less than 4 tons in each of eight years. The average date of cutting of the first crop was June 24th; the second crop, August 2nd and the third crop, September 18th.

Variety Experiments

An experiment which included ten varieties and which occupied seventy-one plots was started in the experimental grounds in the spring of 1909. The exact number of living plants on the different plots were determined each year. When the experiment had been conducted for a period of twelve years the average percentage of living plants for a few of the varieties were as follows:—Ontario Variegated, 66; Grimm, 65; Baltic, 61; Common, 35; Peruvian, 17; and Arabian, 9. The only variety which had a higher percentage of living plants than the Ontario Variegated was the Mongolian but this variety was a light yielder of hay, late in maturing and possessed other undesirable characteristics.

In another experiment in which there were ten varieties and sixty plots and which was conducted for a period of ten years, the highest average yields of hay per acre, per annum, were produced by the Grimm, 3.6 tons, and the Ontario Variegated 3.2 tons.

In each of two separate experiments one continuing for a period of ten years and another for twelve years, the Ontario Variegated gave the highest average yield of hay per acre in the early years of the test and the Grimm in the latter years of the test.

An alfalfa experiment consisting of thirty-four plots was started seven years ago. For this experiment seed of some of the hardiest varieties was obtained from different sources. The average yield of hay per acre per annum for the seven year period was 4.43 tons for the Grimm and 4.42 tons for the Ontario Variegated. The seed of each of these varieties was obtained from five different sources and both varieties have given a higher yield per acre than any of the other varieties in the experiment, including Baltic, Cossack, Semipalatinck, Orenberg, Liscomb Hardy, etc.

Ontario Variegated Alfalfa hay cured in windrows retains more of its leaves than when cured in the swath. The leaves of alfalfa have a much higher feeding value for stock than any other part of the plant. Alfalfa leaves have a higher protein content than wheat bran.

Co-operative Experiments

In each of the past twenty-nine years two small bags of alfalfa seed have been sent to each of 2683 Ontario farmers for co-operative experiments on their own farms. In the last eighteen years, 2144 experimenters have been furnished with sufficient alfalfa seed to sow a plot one rod wide by two rods long of each of the two varieties, Ontario Variegated and Grimm. A number of these experimental plots were sown as far back as 1911 and some still remain unbroken and present results which are both interesting and valuable. Recently a questionnaire was sent to each of these farmers and upwards of three hundred and fifty replies were received. In answer to the inquiry as to which variety of the two gave the better results in the local test, it is interesting to note that in the nine years, 1912, 1913, 1916, 1918, 1919, 1923, 1924, 1926 and 1927, the majority of the experimenters reported in favor of the Ontario Variegated, and in the other eight years the majority reported in favor of the Grimm. Of the total number of farmers who answered this question, 51 per cent. preferred the Ontario Variegated and 49 per cent. the Grimm. In response to another question, replies from farmers indicated that the most extensively grown variety of alfalfa was the Ontario Variegated, with the Grimm variety a good second, and Common, Northern Grown and Turkestan varieties grown in a very limited way.

Not only has the use of Ontario Variegated alfalfa increased rapidly in Ontario but it has also increased in other Provinces and in a number of the Northern States. This is particularly true of the State of New York where there has been for several years a considerable demand for the Ontario Variegated seed. This is most probably due to results of experiments conducted throughout the State in recent years. About twelve years ago at the request of the Extension Department at Cornell University, the Ontario Agricultural College assisted in furnishing a supply of seed of the Ontario Variegated variety which was used in demonstrations in many parts of New York State. In 1920, Professor Barron furnished an interesting report from which the following is quoted:—"You may be interested to know that in New York State the variegated alfalfas stand at the top. The varieties which we had under observation taking this rank: First, Ontario Variegated; Second, Baltic; Third, Grimm." In the summer of 1925, after experiments for another five year period, Professor Barron again sent an appeal for more seed and reported as follows:—"In our experimental work and also in many demonstrations on New York farms the Ontario Variegated alfalfa has been showing great value. During the first two or three years after it is seeded it yields as well as any other strains which live over well in New York State, and a great deal better than many of them. In average field conditions it seems to be longer lived than any of the other varieties which are planted on a field scale. It is the last variety to thin out and be run out with grass and weeds."

Judging from the results of experiments conducted at the College and throughout Ontario and from the experience of practical farmers in this Province and other places it seems evident that the two best hardy varieties of alfalfa are the Ontario Variegated and the Grimm and there is not very much difference in the relative merits of these two. They are both winter hardy and good producers of fodder and of seed. As the price of seed of the Ontario Variegated has been lower than that of Grimm it is likely that the former will be increased more rapidly than the latter until the price of the seed of the two varieties becomes more nearly equal.

Seed Growing

The results of extensive experiments conducted at the Ontario Agricultural College showed that seed production caused no apparent injury to the permanency of the alfalfa crop. The seed crop is usually cut when the pods are dark brown. When the first or second crop in the season is used for seed production it is cut with a self-binder and cured in shocks, with the reaper, or the mower fitted with pea harvester attachments. The latter two machines deposits the seed crop in bunches. Fields where the first cutting of Ontario Variegated was used for seed, sometimes produced a yield as high as twelve to fifteen bushels of seed per acre, and on the average of the several years previous to 1927 between five and six bushels per acre. When the first crop in the season is used for hay and the second for seed the cutting can be done with a reaper or mowing machine with or without an attachment and the material is usually cured in bunches or in windrows. The yield of seed from the second cutting is considerably less than that from the first cutting usually not averaging more than two to three bushels per acre.

A field of the Ontario Variegated variety in Peel County in full bloom and having an excellent stand which is being left for the production of seed.

Three Varieties Described

Ontario Variegated alfalfa has flowers varying in color through different tints, shades and blends of yellow, violet, blue, green and brown. This variety originated from a blend of hardy variegated varieties or strains. The two principal importations came into the Niagara Peninsula of Ontario over fifty years ago from the adjoining Provinces of Lorraine in France and Baden in Germany. This foundation material passing through a rigorous climatic process of elimination for over half a century, has produced a variety of alfalfa which seems particularly suited to conditions of Northern and Eastern America. It is interesting to note that the Ontario winter of 1917-18, one of the severest on record, killed over fifty per cent of the winter wheat and upwards to 45,000 acres of alfalfa. Since that date there have been two severe winters which caused a large amount of winter killing both in winter wheat and alfalfa. These severe winters destroyed the tenderest plants in the fields of this hardy alfalfa, leaving only the very best. The Province of Ontario is now noted for its production of alfalfa of a purely hardy variegated type.

Grimm alfalfa has variegated flowers quite similar to those of the Ontario Variegated. It originated from seed brought from Baden, Germany, about seventy years ago by Wendelin Grimm, who settled in Minnesota where this particular alfalfa is still grown and from which centre it has spread to many States and Provinces. The natural selection of the past seventy years has given this alfalfa an enviable reputation as a very hardy variety. When it is possible to obtain good seed of the Grimm uncontaminated by the Common variety, it is difficult to secure a commercial variety which is more hardy.

Common alfalfa which is a non-variegated type has flowers which are all violet but which may, however, have a range in tone from a pale tint to a dark shade. This variety has been grown extensively for centuries in some of the comparatively warm countries of the world. It is the principal variety grown in Central America, Mexico and the Southern part of the United States where a hardy variety is not required. One of the principal causes for failures in growing alfalfa in Ontario several years ago was due to the use of Common alfalfa seed purchased from seedsmen who imported it in large quantities from such States as Utah, Colorado and even as far south as Texas. The seed of Common alfalfa obtained even as far north as Montana has given results inferior to that of Ontario Variegated and Grimm. The seed of Common alfalfa usually germinates well but the plants kill out in a comparatively short time.

Inspecting a field of Ontario Variegated which is to be used for seed production. This variety under good conditions produces from 3 to 6 bushels of seed per acre. In some cases much larger yields have been obtained.

SEEDING

An experiment was started in 1920 by sowing three varieties of alfalfa on high land and on low land, by using 5, 10, 15, 20, 25 and 30 pounds of seed per acre. As a result of the thirty-six plots cropped three times in each of the past five years the highest average yield of hay per acre, per annum, has been obtained from the use of 15 pounds of seed per acre, which was 4.9 tons. It should be remembered that this seed was of high quality and that the land was in good condition when the plots were sown.

Good results have been obtained in sowing alfalfa in the early spring of the year with a nurse crop of barley or spring wheat, the barley and spring wheat each being sown at the rate of about one bushel per acre, or by sowing the alfalfa seed in the early spring of the year on winter wheat or winter rye after a late snowfall. The melted snow will carry the seed into the ground and usually no after cultivation is necessary. Excellent results have been obtained from sowing alfalfa about July 15th on a well prepared seed-bed when no nurse crop is necessary. At this season of the year the soil contains almost a minimum of moisture and care should be taken to see that the crop is sown soon after a shower of rain.

A few Alfalfa plots, showing the Ontario Variegated in the front, the Grimm in the background, and Common Alfalfa, from the States of Colcrado, Utah, Nebraska and Texas in the centre.

MIXTURES

Of sixteen mixtures of grasses and clovers tested in duplicate plots in each of six separate years' tests the following gave the highest yields of hay per acre per annum: Tall Oat Grass and Alfalfa, 5.2 tons; Orchard Grass and Alfalfa, 4.9 tons; Timothy and Alfalfa, 4.6 tons; Tall Fescue and Alfalfa, 4.5 tons; and Timothy and Common Red Clover, 3.4 tons.

INOCULATING ALFALFA SEED

To obtain the best results in the growing of alfalfa, in catch, vigour of plant and quantity of crop produced, it is necessary that the alfalfa bacteria gain entrance to the roots of the growing plants, where they produce nodules and enable the plants to utilize the free nitrogen of the atmosphere instead of depending on the nitrates in the soil for their nitrogen food supply. Sometimes these bacteria are already in the soil, particularly in districts where sweet clover grows either as a weed or as a cultivated crop, as the bacteria that produce nodules on sweet clover will also produce nodules on alfalfa.

In most districts in Ontario, however, these particular bacteria are not in the soil, and consequently if one is to get the best results from an alfalfa seeding it is necessary to introduce the bacteria. This is most readily done by inoculating the seed with the alfalfa bacteria nitro-culture before sowing.

An alfalfa nitro-culture such as may be obtained from the Bacteriological Department of the Ontario Agricultural College, Guelph, for 50 cents, contains enough bacteria to inoculate a bushel of alfalfa seed. If the instructions sent with the culture are followed, every seed in the bushel will be covered with numbers of the bacteria, so that when the seed germinates in the soil the bacteria will be right there ready to invade the young roots where they will develop and do their good work. Experience has shown in a large number of cases that it pays to inoculate every time alfalfa seed is sown, as inoculation ensures the bacteria being on the job.

FERTILIZERS AND LIME

Alfalfa is a deep-rooted crop and consequently gathers much of its mineral food readily and does not respond to manuring as do other crops. While it is a lime-loving crop its deep roots make it somewhat independent of surface conditions and the crop is frequently found growing well where the surface soil is quite acid. In practically all Ontario soils there is an abundance of lime in the subsoil and when the roots get into this area they doubtless secure an abundance of lime.

STAGE OF CUTTING

When cut at the right period of its growth and properly cured, alfalfa furnishes more digestible proteins than the clovers, or any other fodder; more even than the cereal grains. It is, in fact, the best protein-producing plant grown on Ontario farms.

A Fifteen Year Old Stand of Ontario Variegated Alfalfa.

Because of the rapid development of fibre, it is important that alfalfa be cut just as it commences to blossom. Some years ago we made a careful study of composition as affected by maturity. The object was to determine at what stage in its growth the plant should be cut to yield the maximum amount of digestible matter. Without going into details of the data obtained, it may be sufficient for present purposes to state that while there was a gradual decrease in the digestibility as the plants matured, the largest amount of digestible matter was present when the alfalfa was cut in the early blossoming stage. The following figures bear out this statement and emphasize the need of cutting alfalfa at an earlier stage in its growth than the clovers.

	Dry Matter per acre	Digestible dry matter per acre.
	lbs.	lbs.
Buds formed	2,713	1,590
Two weeks later when one-third in blossom	3,525	1,978
Two weeks later when in full bloom	3,142	1,611

The data obtained at that time and in work done since has also shown that the second crop of any one season is slightly richer in protein than the first crop.

THE FEEDING VALUE OF ALFALFA

One of the valuable features of alfalfa is its richness in the expensive proteins. When cut at six or eight inches in height, we have found it to contain 25 per cent. of nitrogenous matter, that is, one-quarter of the dry matter of the crop was crude protein. The amount naturally decreased as the plants matured, owing to the development of the fibre, but in the early blossoming stage we found alfalfa contained on the average 15.5 per cent. of crude protein, or 11.3 per cent. of digestible crude protein, calculated to water free basis. In hay condition of dryness, Henry and Morrison in "Feeds and Feeding" give the per cent. of digestible protein in some of the common fodders as follows: Alfalfa, 10.6; red clover hay, 7.6; timothy hay, 3.0; corn silage, 1.1; and among the grains: Oats, 9.7; corn, 7.5; barley, 9.0; and wheat bran, 12.5. It will thus be seen why it is not necessary to feed so much grain or concentrates when alfalfa is used as the fodder.

Furthermore, the alfalfa is valuable for its A and B vitamines and its ash content. It may not be better in these respects than the clovers, but it has a recognised value when fed with concentrates.

The Ontario farmer's feed problem is best solved through the production and use of the greatest possible quantities of high-class home-grown roughage, which obviates the necessity of using a large proportion of expensive concentrates in his rations. Most home-grown concentrates, and many of the roughages, are carbonaceous feeds which, in themselves, even in mixtures, do not make for properly balanced rations and consequently, there is always a big demand for protein-rich feeds such as bran, shorts, middlings, oilcake meal, cottonseed meal, gluten meal and other similar feeds. These feeds are always more or less expensive and it is sound farm economics to attempt to produce substitutes for them in so far as possible. The farmer understands the situation and naturally turns to leguminous crops, particularly the clovers, to cut down his feed bills and at the same time, enrich his soil. He realizes that his home-grown grains and his corn and roots are low in protein. He knows that protein-rich concentrates are high in price. Therefore, he is interested more and more in an increased supply of home-produced feed high in protein. It is also a fact that these leguminous feeds are high in mineral matter so necessary to production, reproduction and general health in herds and flocks, and the best of them is alfalfa. It is the most palatable of all.

From the feeder's viewpoint, alfalfa stands out among the legumes for hay and for soiling purposes while it gives fair results for pasture and may be used in times of bad curing weather for silage. Alfalfa is of outstanding value as a roughage feed.

ALFALFA HAY

Alfalfa hay stands at the head of the hay list in value for dairy cows, sheep and lambs, beef cows, growing young cattle, breeding bulls, and may be used with care for horses, especially when they are idle or comparatively so. Of course, the hay should be well cured, preferably by the coil method, and generally speaking the second cutting is of finer quality than the first. Good alfalfa hay is just under wheat bran in digestible crude protein, but shows about three times as much fibre. It is a roughage, but some feeders forget that it is a rich roughage and throw too much of it to their stock. A small forkful of good alfalfa hay contains more real feed value than a big bundle of the average timothy or mixed hay and so it should be fed with more care to prevent waste or danger from overfeeding. Alfalfa hay, corn silage and a few roots make an ideal roughage ration for all classes of cattle and sheep and many feeders have cut down, or cut out, their corn acreage where alfalfa does well. For dairy and beef cattle, from one-half to one pound per day per hundred pounds of live weight, according to other feeds fed, proves very valuable in mixed rations. For sheep, either fattening lambs or breeding ewes, from two to four pounds per day will be relished. For horses, not over one-half pound per hundred pounds live weight, preferably mixed with other hay or straw, is safer than using a larger quantity. For the breeding sows, it may also be used as part of the winter ration.

When the weather is uncertain it is advisable to place Alfalfa hay in coils. While this requires time and labor it is a satisfactory method. Alfalfa hay cured by this method should be carefully handled in order that the leaves and finer parts may be saved.

ALFALFA AS A SOILING CROP

For this purpose nothing excels alfalfa. It grows rapidly and produces several crops in the season. Green alfalfa cut and carted to all stock kept stabled during the summer provides protein-rich succulence in the most palatable form. The crop will produce more feed cut and fed as a soiling crop than in any other form. Mature cattle may be fed up to fifty or sixty pounds per day of this green feed along with other feeds. Calves and younger stock do exceedingly well on alfalfa used in this way. Show or fattening sheep can have no better feed. It is among the best green feeds for all classes of hogs from the youngest pigs to older breeding stock. Green alfalfa is not a very satisfactory feed for the working horse because it has a tendency to cause washiness.

Alfalfa, used in this form, provides in itself a narrow ration, being very high in protein. It should be fed along with home-grown grains, a little hay or corn silage, to cattle. Sheep will handle it without much difficulty and, of course, it naturally is only a supplement to the grain ration for hogs, but, as such, it will cut down the cost of pork production very materially. If fed green to horses it should only comprise a part of the ration along with some dry hay and grain. When feeding to cattle and sheep it is well to start with a small amount and that dry, as there is some danger of bloat if large quantities are fed wet in the beginning.

ALFALFA PASTURE

While alfalfa has its greatest value as a hay and soiling crop, it may be used to some extent for pasture. On the College farm, it is particularly valuable in mixtures with other clovers and grasses because of the fall pasture it gives. Where the crop does well it will yield an abundance of excellent feed as pasture for beef and dairy cattle, sheep and swine. Care is necessary that it be not pastured too closely. Too many sheep or cattle on a given acreage may ruin the stand. It is one of the best hog pastures known. It is a little washy for work horses, but excellent for the idle horse. Care is necessary in turning ruminant animals on alfalfa pasture. At first, they should be allowed on it only for an hour or so in the middle of the day, when it is dry. Wet or frosty alfalfa is very likely to cause bloat and there is some danger of this trouble even after cattle and sheep have become accustomed to it, but, with care, the crop, on suitable soil, will give good results for pasture if it is not eaten down too closely.

The Ontario Variegated variety produces an abundance of pasture of high quality. Care should be taken that alfalfa be not too heavily pastured at any time or pastured too early in spring or too late in autumn.

ALFALFA SILAGE

Alfalfa may be made into silage, but this practice is only warranted in weather too wet to permit of curing into hay. It should be ensiled green or wet and well tramped. If properly put in, it will make fair feed, but it is too rich in protein to make the best silage and therefore it is better practice to cure into hay when this is possible. Unless the crop goes into the silo just right, it is liable to make very poor feed. Properly cured, it will make fair silage and is fed out as one feeds corn silage, but in slightly smaller proportions.

ALFALFA MEAL

Alfalfa hay is sometimes ground into meal. Feeders often make the mistake of considering this meal a concentrate. It is still a roughage and its feeding value depends entirely upon the quality of the hay from which it is made. There is little, if any, advantage in pulverizing good alfalfa hay into meal for the average farm stock. Sometimes poor alfalfa hay is ground, and it might be well where buying the meal to do so on analysis. The one big advantage of the meal is in matters of transportation and in mixing feeds. However, on the farm, good alfalfa is a surer feed than the meal.

ALFALFA FOR POULTRY

Alfalfa is used extensively in the mashes for poultry. In many of the egg-laying mashes, offered for sale, there is from five to ten per cent. of ground alfalfa hay, or what is commonly sold as alfalfa meal.

An unprofitable alfalfa field, one having a poor stand and containing a large percentage of weeds of many kinds. Such fields should be ploughed, cropped and resown.

We have fed the second crop of good quality to our laying hens during the winter months. With us, the hay is put through a cutting box, cutting as short as the machine will allow. This cut hay is then fed in racks and the hens allowed to eat what they wish. Roughly, four hundred hens will eat about one thousand pounds a month. They do not eat all the stems; the leaves, of course, are the best feed. This hay is green, is high in mineral content and is relished. Some steep the leaves, then mix the leaves and the liquor along with the ground grains and feed as a moist mash.

We find an alfalfa field is one of the best ranges in which to grow young stock. The chickens relish the alfalfa and grow well. For small chickens, the field should be cut, or some loss will occur from the long, wet alfalfa.

For years we have used cut alfalfa hay for litter for the baby chicks. We have not used any other material for this purpose that has given us as good all-round results. The little chicks eat most of the leaves and blossoms, which are good for them. The stem that is left is all right for scratching material. Cut alfalfa appears to be a very satisfactory litter for chicks.

One should be careful not to use hay that is not properly cured. Any kind of mouldy litter or feed is bad for poultry.

Every poultryman, if possible, should have a patch of alfalfa for cutting green for the hens, or as a range for chicks. The cured hay is good feed for both the chicks and the older birds.

It is not good practice to raise chickens year after year on the same ground, hence alfalfa fields used as chick ranges should be those that you intend plowing next year.

ALFALFA HONEY

In the Western States, where alfalfa is grown in large acreage, it has proven a wonderfully good producer of a fine quality of table honey.

Thus far in Ontario, except in a few places, alfalfa has not been grown in sufficient acreage to give a surplus of honey to the beekeepers. During the past few years alfalfa honey has been reported in Ontario, and when the acreage is increased, alfalfa should prove an added source of profit to the beekeeper. Honey can only be secured from alfalfa when the crop is grown for seed or left in flower for some time.

HINTS FOR SUCCESSFUL ALFALFA PRODUCTION

Select land having a clean, mellow, fertile surface soil, preferably of a calcareous nature, and overlying either a naturally or an artificially well-drained sub-soil.

Use large, plump, pure seed of strong germinating power of a hardy productive variety and inoculate the seed with the proper kind of bacteria.

Sow the seed at the rate of fifteen to twenty pounds per acre and preferably in front rather than behind the tubes of the grain drill.

As results of experiments it has been found that alfalfa seed may be sown to advantage as follows:—

(1) Alone on winter wheat or winter rye very early in the spring when the land has a fresh, light covering of snow.

(2) With a nurse crop such as barley, spring wheat or rye, or even with oats if the latter is sown thinly.

(3) As the only crop on a good fallow in the month of July, preferably about the middle.

When pasturing alfalfa never permit it to be eaten off closely, and never cut or pasture late in the autumn, and thus ensure a good protective growth for the winter.

If the suggestions here given are carefully followed, alfalfa may be expected to produce large and valuable crops for a number of years without re-seeding.

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Hay and Pasture Crops

BY W. J. SQUIRRELL, B. S. A., PROFESSOR OF FIELD HUSBANDRY.

Hay and pasture crops including the grasses, clovers, and other forage plants, constitute the most valuable group of plants grown on the farms of Ontario. Over 7,000,000 acres of land which is about half the total area in cultivation are used annually to produce the hay and pasture crops of the Province. The hay and clover crop is valued annually at more than $50,000,000 for the past 45 years or over $80,000,000 annually for the past five years, 1924-8. The pasture crop whose acreage in the average of forty-five years was slightly less than that of hay has a value about as great as the hay crop. Good pasture produces the most economical gains with most classes of livestock. The following table gives the average acreage occupied in Ontario by hay, pasture, small grains, corn, potatoes and roots, for the past forty-five years, in periods of ten years except for the last period which is for a period of five years only:—

Periods of ten years.	*Hay and Clover	Pasture	Small Grains	Corn	Potatoes	Roots
1884-1893	2,401,035	2,691,261	4,754,695	212,383	151,527	143,512
1894-1903	2,535,534	2,758,833	5,202,579	510,132	163,995	209,835
1904-1913	3,352,000	3,211,068	4,933,581	581,522	156,573	187,223
1914-1923	3,605,451	3,439,459	4,617,740	690,816	161,016	139,368
1924-1928	4,206,924	3,120,371	4,380,049	526,752	165,503	147,470

The largest area of land used for growing pasture and corn, occurred during the period 1914-1923, or during the years of the World War and the five years immediately following. The greatest acreage of small grains and roots was grown in the ten year period, 1894-1903; and of potatoes and hay in the period, 1924-1928. Although hay and pasture crops have increased in area during recent years there has been very little improvement in the quality of most of the crops grown for these purposes.

Much improvement is still possible in the hay and pasture crops through the medium of selection and hybridization; the choice of the most suitable varieties to use in hay and pasture mixtures; the use of artificial fertilizers to increase the yield and improve the quality; and better management of these crops.

DESCRIPTIONS, DRAWINGS, AND AGRICULTURAL IMPORTANCE OF HAY AND PASTURE PLANTS

In all twenty-six varieties of grasses, clovers and similiar crops are discussed individually under the above heading. The second part of the bulletin covers the results of experiments conducted at the Ontario Agricultural College in testing various crops both singly and in combination for the production of hay and pasture.

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*Including Alsike, Alfalfa and Sweet Clover.

Timothy Grass (*Phleum pratense*).

Other common names: Meadow Catstail, Herd's grass.

HISTORY.—Although this grass is a native of Europe, its agricultural value was first recognized in America. It was introduced from England into the State of Maryland by Timothy Hanson, from whom it takes its name, about 1720. In the New England States it is known as Herd's Grass because of its introduction into New Hampshire by John Herd.

BOTANICAL DESCRIPTION.—Timothy is a hardy perennial grass possessing a short root stalk. The stems which are erect and smooth sometimes grow to a height of four feet. The leaves are short and flat. The inflorescence is in the form of a spike with the spikelets, which are one-flowered, arranged in a dense cylindrical form. The heads of timothy are distinguished from those of Meadow Foxtail by being larger and coarser and having no soft white hairs.

HABITS OF GROWTH.—Timothy is a slow growing grass, starting late in the spring and usually producing little second growth after being cut for hay. It produces flowers early in July and ripens seed about a month later.

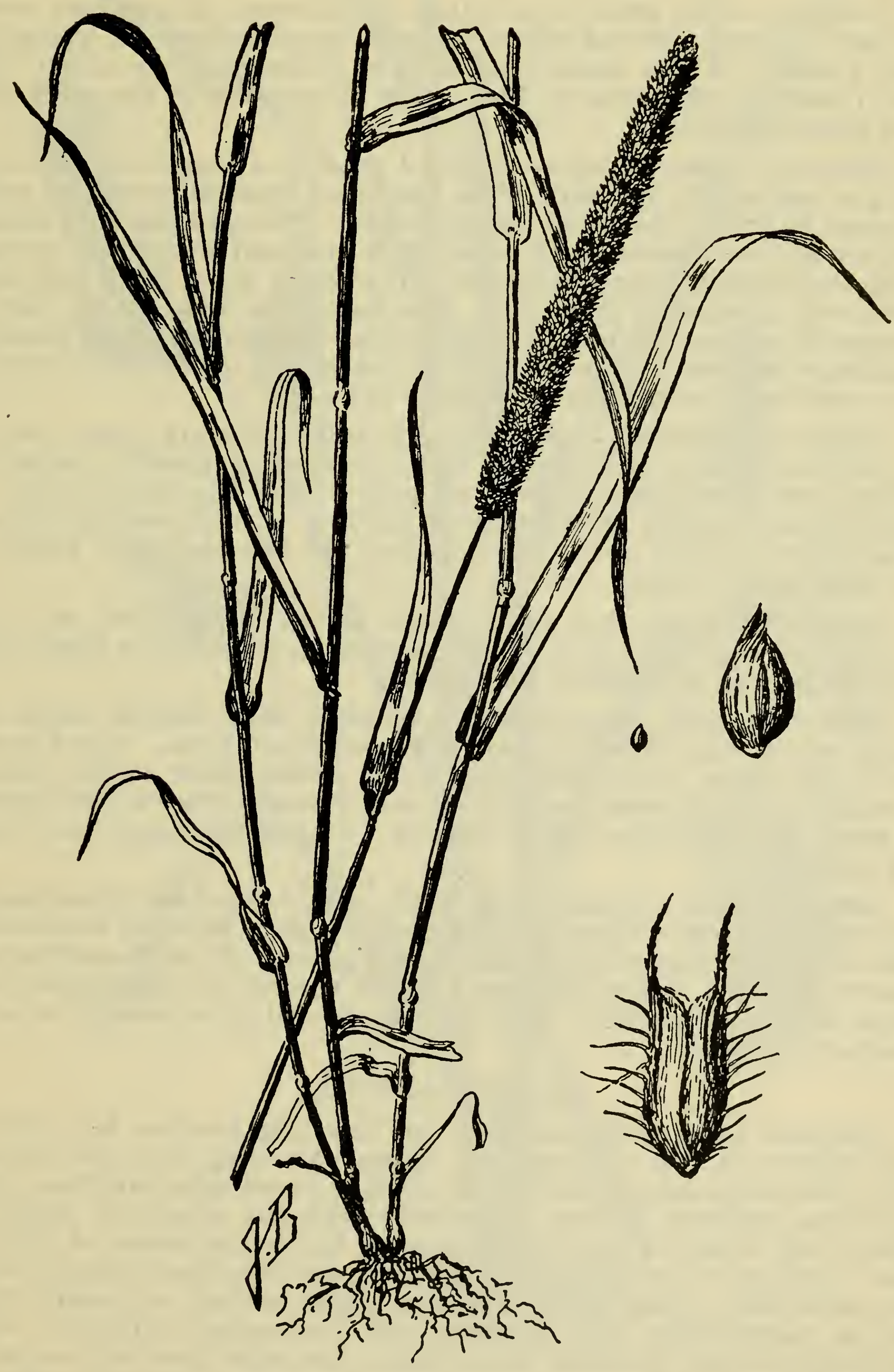
SOIL.—Timothy may be successfully grown on a variety of soils but is best adapted to clay loams which contain a good supply of moisture. Sour soils, sandy soils and those soils which dry out badly during the hot part of the summer are not so suitable for growing timothy.

SEED.—Timothy seed, for the best results, should be comparatively large in size, plump, of a bright silvery color, free from impurities and very little hulled. It is one of the best seed producers among grasses, and is ready to cut for this purpose when the spikes turn from green to yellow. Threshing is accomplished with the ordinary grain thresher, although the best seed on the market is flail-threshed. The legal weight per measured bushel is 48 pounds.

SEEDING.—Owing to its weight and shape, timothy is easily sown. In Ontario timothy is successfully sown with cereal crops both in the autumn and spring of the year. From 12 to 15 pounds are used per acre when this grass is not seeded in combination with clovers and other grasses. From 4 to 8 pounds per acre are used when sown in mixtures.

Agricultural Value.

Timothy is the best known and the most widely grown of all the grasses in Ontario. It is essentially a hay grass producing a large amount of stems and a small amount of leaves. Its popularity is justly due to its many good qualities. (1) Its seed is comparatively cheap and readily obtainable. (2) The seed is less likely to contain weed seeds than most of the other grasses. (3) The crop is easily cut and cured. (4) There is less danger of the hay spoiling from being over-ripe before cutting than there is with other grasses. (5) It produces a large yield of hay of good quality. (6) On account of suitable digestibility, timothy is a favorite grass for work horses which are required to work immediately after feeding. For the best results in making hay, timothy should be cut when the plants are in bloom. It is one of the easiest of all the grasses to cure and wastes little in handling and in transportation. Because of its late start in the spring and its inability to stand the hot dry weather of the summer, timothy is only a fair pasture grass. This grass shows a great deal of variation in the individual plants and much improvement is possible by selection.



Timothy Grass
(*Phleum pratense*).

Orchard Grass (*Dactylis glomerata*).

Other common names: Cocksfoot, Rough Cocksfoot.

HISTORY.—This grass is a native of Europe, its common name, "Orchard," being derived from the success attending its growth in shady places. It has been cultivated in America since about 1760. After Timothy and Kentucky blue grass, it is probably the most cultivated grass in Ontario.

BOTANICAL DESCRIPTION.—Orchard grass is a long-lived perennial, having a very short root stalk. The heads are branching and the spikelets borne in dense clusters on the branches. The spikelets may contain from two to five flowers, each of which is enclosed within two strongly keeled and sharply pointed glumes. The stems grow erect and sometimes reach a height of three feet. The leaves are long, broad, flat, not as coarse in texture but more abundant than in timothy. This grass has a tendancy to grow in close tufts, and forms one of the best examples among cultivated grasses of a "bunch" grass.

HABITS OF GROWTH.—Orchard is a quick growing grass, starting early in the spring, producing a large amount of growth during the summer and continuing to grow vigorously into the late autumn. It shoots up very quickly after being cut for hay. The flowering period is in the latter part of June and it reaches the hay condition about the same time as red clover.

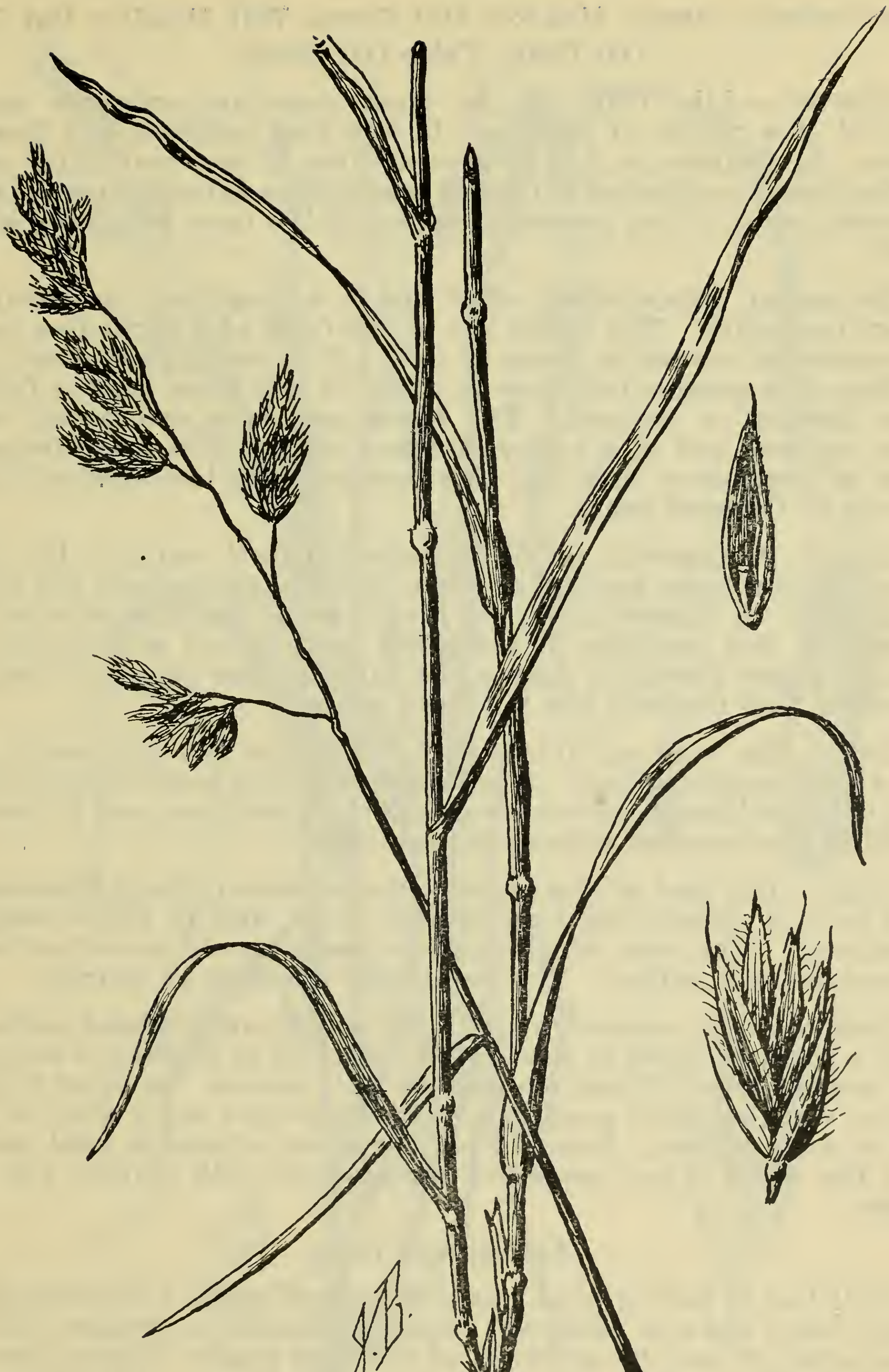
SOIL.—While Orchard grass is best suited for growing on a rich, well drained, clay loam soil, it will succeed on soils with a lesser moisture supply than is required for timothy.

SEED.—Orchard grass seed is somewhat boat shaped, about one-quarter of an inch in length and possesses short awns. Good seed is of a bright straw color, free from weed seeds, other seeds and dirt. It is ready to cut for seed about three or four weeks after it has flowered and when the seeds are straw colored. The legal weight per bushel is 14 pounds.

SEEDING.—On account of its light weight Orchard grass seed is more difficult to sow than timothy seed. It may be sown successfully either in the autumn or spring with cereal grains. From 25 to 30 pounds is sown per acre, when this grass is not seeded in combination with clovers and other grasses. The method of seeding is usually to sow it broadcast by hand.

Agricultural Value.

Orchard grass is grown both for hay and pasture but its chief value lies in its use for pasture. Close pasturing does not seem to injure Orchard grass and lessens its habit of growing in bunches. Grass and clover mixtures grown in Ontario with the object of producing pasture will nearly always be improved by the inclusion of Orchard grass. Orchard is one of the very best grasses in withstanding drought. The palatability of the grass is almost equal to that of timothy but it loses its palatability more rapidly with increasing maturity. When it is grown for hay, it should be cut early, not later than the commencement of bloom. After this period, it deteriorates in quality, soon becoming woody. Like timothy, Orchard grass is quite variable in its individual plants, showing great differences in height, coarseness of stem and leaf, leafiness, earliness, etc. There would appear to be almost as great a chance for improvement by selection with this grass as with timothy.



Orchard Grass
(*Dactylis glomerata*).

.. Tall Oat Grass (*Arrhenatherum elatius*).

Other common names: Meadow Oat Grass, Tall Meadow Oat Grass, Oat Grass, False Oat Grass.

HISTORY.—Like many of the most important economic grasses, Tall Oat is a native of Europe. It was first cultivated in Southern France. In Ontario up to the present time, it has been little grown. In experiments conducted at Guelph which have extended over a period of several years, it has proven to be one of the most promising grasses tested.

BOTANICAL DESCRIPTION.—Tall Oat is a long-lived perennial with a short root stalk. The heads are in the form of a spreading panicle and somewhat resemble those of oats. The stems grow fairly erect but there is a greater tendency to droop in this grass than is found in either timothy or orchard. The leaves are long and broad, rather soft in texture, and of a yellowish-green color. This grass frequently grows in bunches or tufts but this peculiarity is less marked than in the case of Orchard grass.

HABITS OF GROWTH.—Tall Oat starts growth early in the spring and provides a large amount of green material throughout the summer and autumn. It flowers about the same time as Orchard grass and also reaches the hay condition at about the same period as this grass. In mixtures where Kentucky Blue and Canadian Blue grasses do not gain admission, Tall Oat will last for many years.

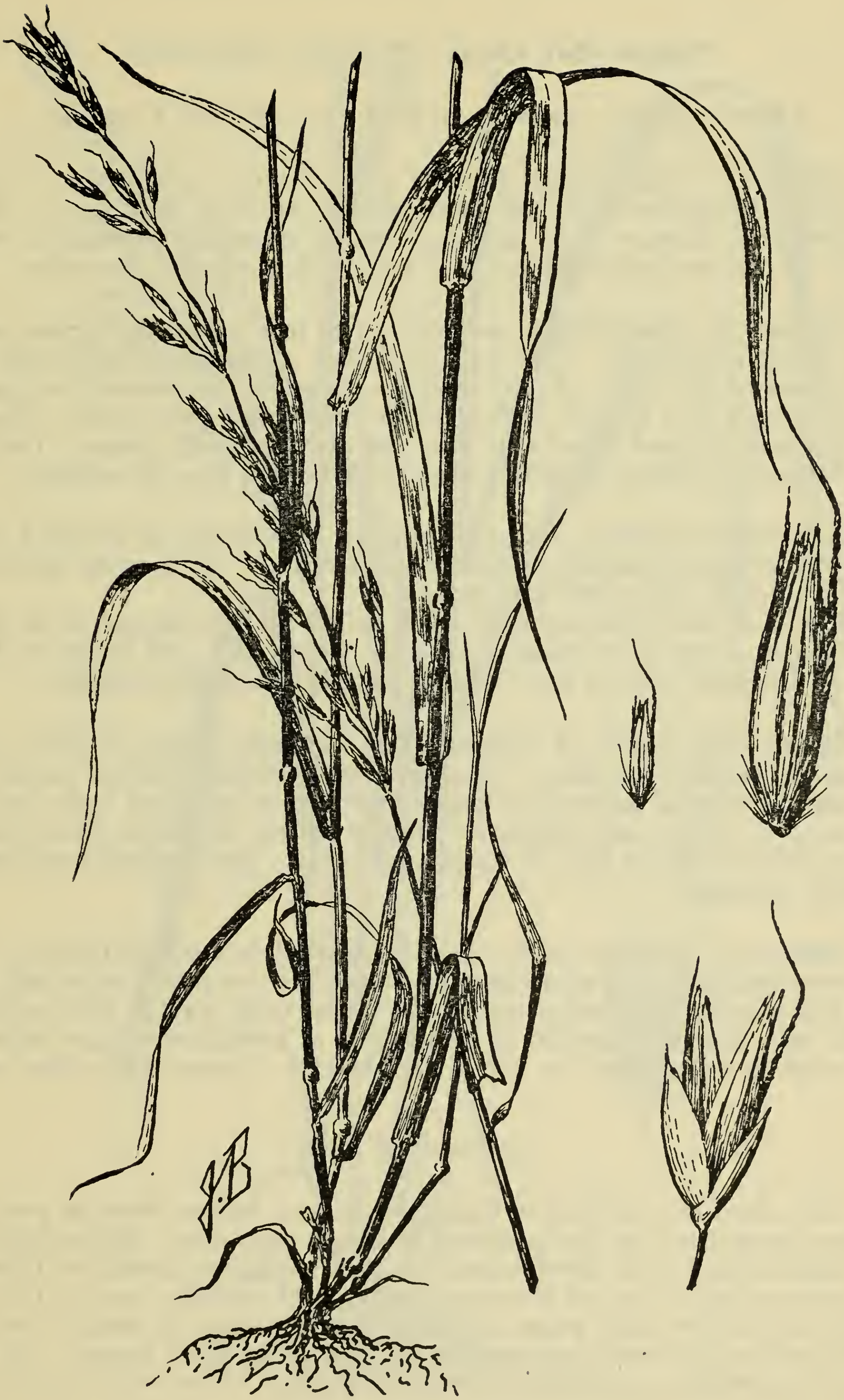
SOIL.—The most suitable soils for Tall Oat are rich, moist loams with a good supply of lime. It will, however, give good results on other types of soil where there is a good supply of moisture, and is noted for its ability to give good returns on poor soils.

SEED.—The seed of this grass is straw-colored, about three-eighths of an inch in length, has long twisted awns, and in shape resembles hulless oats. The seed which shatters easily should be cut as soon as the panicles turn yellow. The weight per bushel is 12 pounds.

SEEDING.—On account of its light weight and twisted awns, Tall Oat is a difficult grass to sow. This difficulty of seeding is one of the chief reasons why it is not more extensively grown. In order to obtain an even distribution of seed, it is often mixed and sown with the grain used as a nurse crop. From 30 to 35 pounds of seed is used per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Tall Oat is both a good hay and pasture grass and gives its best returns when sown in mixtures. In its resistance to drought, Tall Oat is the equal, if not the superior, of Orchard grass. When grown for hay, it should be cut at the commencement of bloom. If left later than this stage it soon becomes woody and unpalatable. In Ontario this grass will frequently produce two good crops of hay in a season. This hay is somewhat more difficult to cure than timothy. Its earliness of growth and the large quantity produced, along with its ability to stand tramping, make it one of the most valuable of pasture grasses. Tall Oat grass is possessed of a certain bitterness of taste which animals do not at first like, but when they become accustomed to it, however, they will eat the grass quite readily.



TALL OAT GRASS
(*Arrhenatherum elatius*).

Yellow Oat Grass (*Trisetum flavescens*).

Other common names: Golden Oat, Yellow False Oat.

HISTORY.—This grass which is also a native of Europe is only of secondary importance in the agriculture of that continent. In both England and France, it is used as a minor grass in permanent pasture mixtures. Its agricultural value is not well known in Ontario.

BOTANICAL DESCRIPTION.—Yellow Oat is a perennial grass, possessing a short root stalk. The heads of this grass are smaller and finer than those of tall oat. From a green color in the immature grass the heads change to a golden yellow at the period of flowering. The stems which are short and fine in texture are covered with hairs. The leaves also, because of their covering of soft hairs, are fine in texture.

HABITS OF GROWTH.—Under suitable conditions of soil and climate, Yellow Oat grass quickly becomes established. It flowers at about the same period as does Orchard grass.

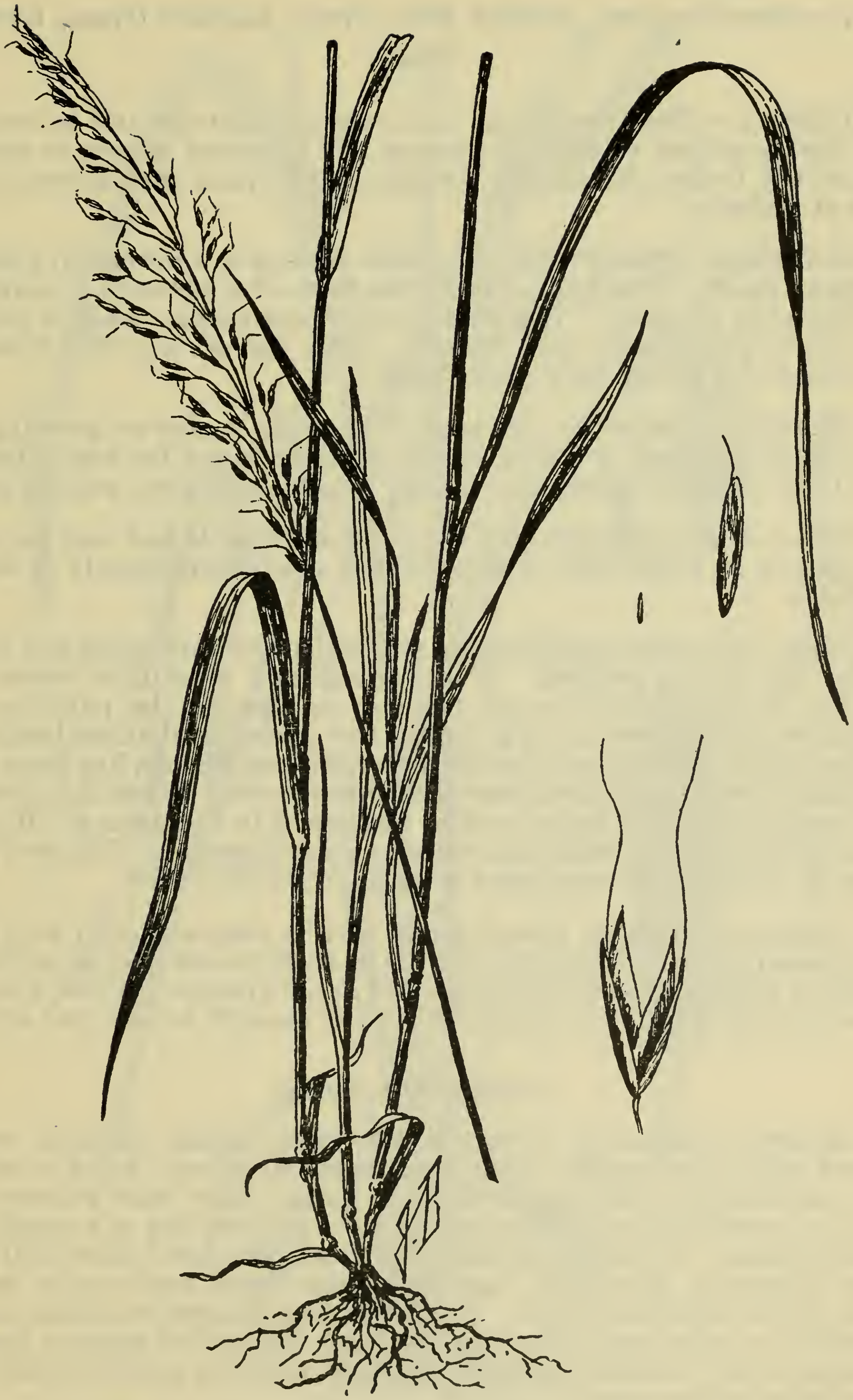
SOIL.—A well drained clay loam soil is the best suited to its growth. Yellow Oat gives poor results on soils which dry out badly in the hot time of summer and on soils which contain excessive moisture.

SEED.—The seeds of Yellow Oat resemble those of Tall Oat but are much smaller in size. They are of a golden yellow color, about three-sixteenths of an inch in length, and have long and very fine awns. The seed is often very impure, usually being obtained from mixtures where Yellow Oat is one of the ingredients. The weight per bushel is about 6 pounds.

SEEDING.—Because of its light weight, it is very difficult to obtain an even distribution in seeding this grass. When sown it is usually mixed with the seed of the grain used as a nurse crop and is even sometimes mixed with sand. From 20 to 25 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

The chief use of Yellow Oat grass is as a minor grass in permanent pasture mixtures and for growing in lawn mixtures. Where this grass has been included in permanent pasture mixtures tested at Guelph, it has proven to be one of the most persistent grasses used. The palatability of Yellow Oat grass is high. All classes of stock like it and cattle will eat it nearly as readily as Kentucky Blue grass. As a lawn grass, it possesses considerable value, forming a fine turf if kept closely cut.



YELLOW OAT GRASS
(*Trisetum flavescens*).

Meadow Fescue Grass (*Festuca elatior*).

Other common names: English Blue Grass, Randall Grass, Evergreen Grass.

HISTORY.—Meadow Fescue is a native of Europe and is one of the most highly prized of English grasses. It is widely grown in some sections of the United States and Canada and is quite well known in some parts of Ontario.

BOTANICAL DESCRIPTION.—Meadow Fescue is a perennial grass lasting many years. The heads are in the form of a spreading panicle and are distinctly nodding. The stems, which sometimes reach a height of three feet, are slender and smooth. The leaves are flat, broad and thick, and of a glossy dark green color.

HABITS OF GROWTH.—Meadow Fescue is a slower growing grass than either Orchard or Tall Oat. It is ready to cut for hay a few days later than Orchard grass and usually produces a good second growth.

SOIL.—It gives its best results on rich moist soils and may be successfully grown on sandy soils where there is a sufficient supply of moisture available.

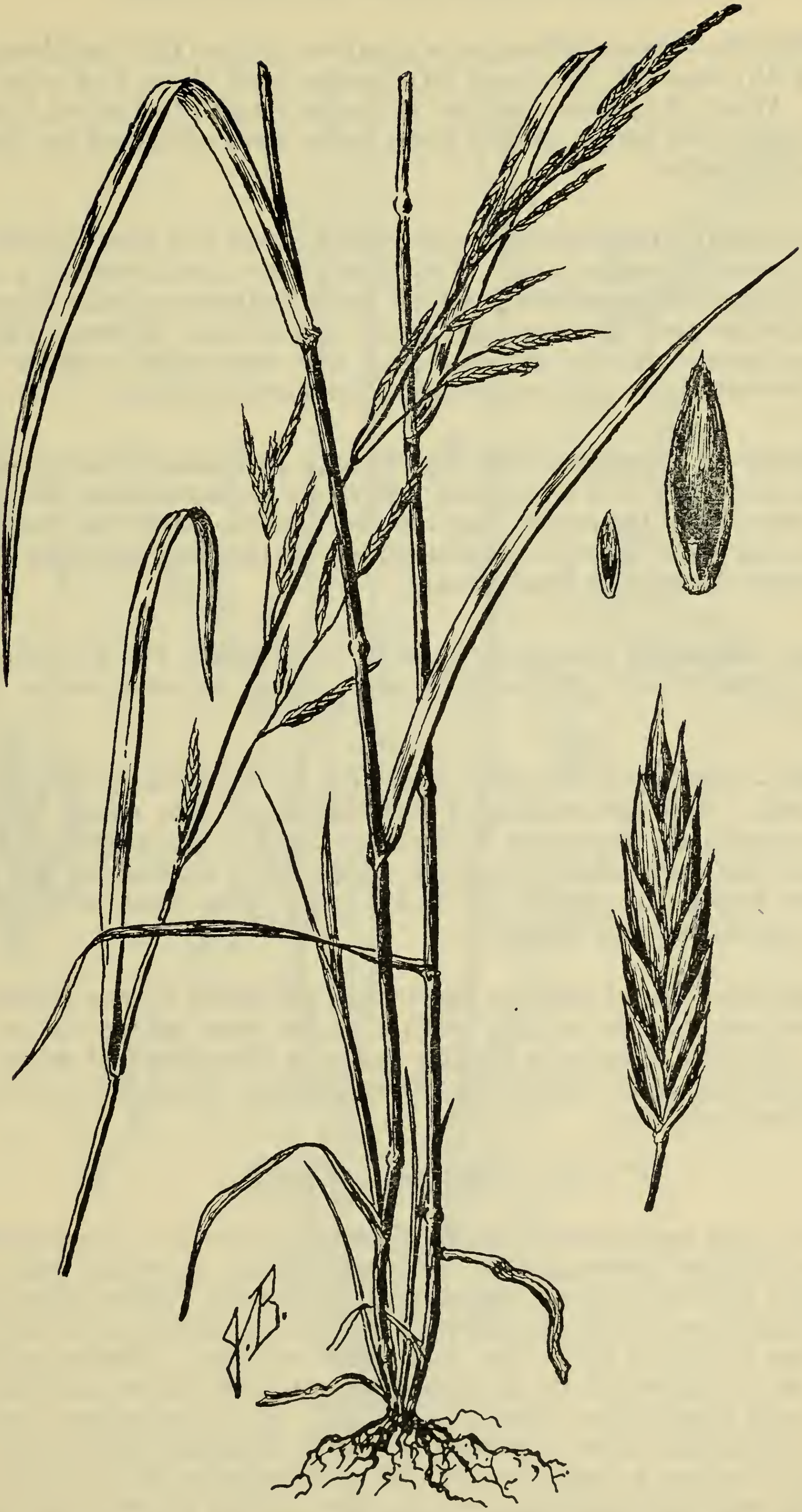
SEED.—The seed considerably resembles Orchard grass but is larger in size and not so pointed. It is awnless and of a light brown color. Meadow Fescue should be cut for seed as soon as the panicles of the head have turned brown. If left after this period, it shatters badly. It is a large yielder of seed and, under favorable conditions, has been known to produce seed crops for a period of three years. When it is grown for seed production, it is better not to pasture it in the spring. It may be successfully threshed with the ordinary grain thresher. The seed weighs about 25 pounds per measured bushel.

SEEDING.—Meadow Fescue grass seed is comparatively easy to sow and is usually sown at the rate of from 35 to 40 pounds per acre when not seeded in combination with clovers and other grasses. When it is grown for seed production, 20 pounds of seed is enough to sow per acre.

Agricultural Value.

Meadow Fescue is a very hardy grass, being strongly resistant against cold and drought. This grass is nearly always sown in mixtures and combines hay and pasture value better than most grasses. It is inferior to timothy in quality and in yield of hay, but is a much better pasture grass. It reaches its best hay condition just before full bloom. After flowering, the stems rapidly become hard and woody and lose much of their nutritive value. Because of its drought-resisting qualities, its ability to stand tramping and the large amount of pasture produced in summer and autumn, Ontario pasture mixtures could usually profitably include this grass.

Tall Fescue is very closly related, botanically, to Meadow Fescue. It shows the following physical differences:—greater height, somewhat coarser texture, later maturity, and a more vigorous second growth. The seeds of this grass can not be distinguished from those of Meadow Fescue.



Meadow Fescue Grass
(*Festuca elatior*).

Sheep's Fescue Grass (*Festuca ovina*).

HISTORY.—Sheep's Fescue is a native of the Old World and is found growing throughout the most of Europe and Asia and also Northern Africa. While it is also a native of Canada and the United States, many of the cultivated forms of this grass have been obtained by these countries from Europe.

BOTANICAL DESCRIPTION.—Sheep's Fescue is a short-lived perennial which grows in dense tufts. The flowers are produced in a small one-sided panicle. The spikelets which contain three or four flowers are of a green color and have in addition a violet tint. Sheep's Fescue grass produces many slender stems which are somewhat angular in shape. The leaves are very narrow and of a pale green color.

HABITS OF GROWTH.—Sheep's Fescue produces little growth during the year in which it is sown and begins to go back after the third year. When once established, it commences growth early in the spring and continues to grow into the late autumn. It reaches maturity a few days earlier than Kentucky Blue grass.

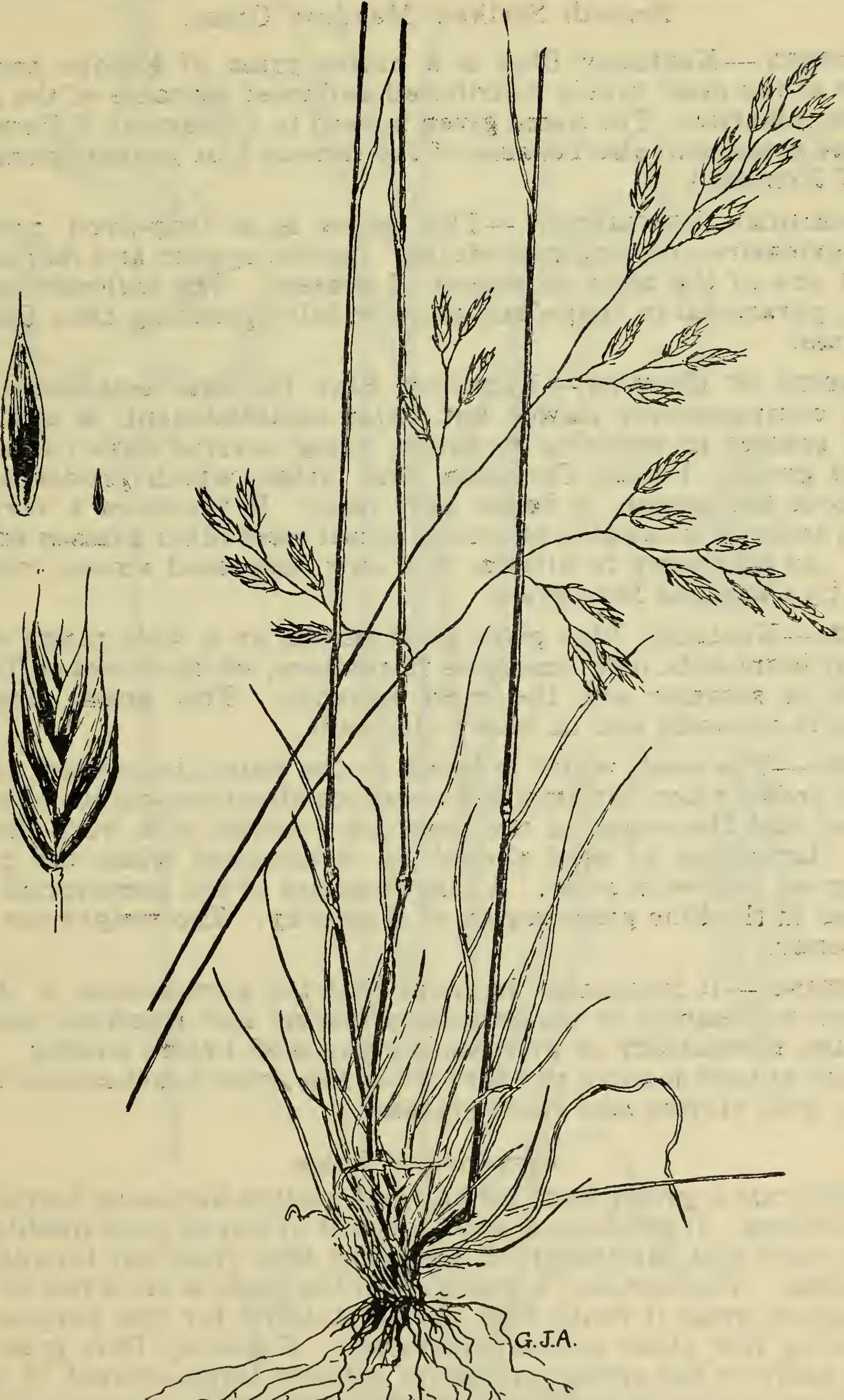
SOIL.—Sheep's Fescue is especially valuable for growing on poor, sandy, or stony soils, surpassing most other grasses under these conditions.

SEED.—The seed is about one-third of the size of Meadow Fescue grass seed. It is straw-colored and has short fine awns. Commercial seed is nearly all produced in Europe and is comparatively cheap. If over-ripe the seed shatters easily. The crop should be cut when the spikelets break up readily in the hand. The seed weighs about 10 pounds per measured bushel.

SEEDING.—Good catches have been obtained where Sheep's Fescue has been sown in the spring with a nurse crop of barley or of spring wheat. Sheep's Fescue is usually sown in mixtures but when not sown in combination with clovers or other grasses, from 20 to 25 pounds of seed is sown per acre.

Agricultural Value.

The chief agricultural value of Sheep's Fescue is for growing under those conditions not suitable for successfully growing other grasses. It usually makes a sheep pasture on poor soils where other and more valuable grasses cannot be grown. Opinions differ as to the ability of this grass to stand tramping and close grazing. Some writers claim that it is unsurpassed in its ability to support these conditions, while others hold almost the opposite opinion. In experiments conducted at Guelph extending over a period of years, it has produced less pasture than the average grasses tested and was inferior in its ability to stand tramping and close grazing to a number of the grasses included in the test. The hay produced from Sheep's Fescue is of fairly good quality but the yield is too small to warrant it being grown for this purpose. Sheep's Fescue and other closely related species are frequently included in lawn grass mixtures.



SHEEP'S FESCUE GRASS
(*Festuca ovina*).

Kentucky Blue Grass (*Poa pratensis*).

Other common names: Blue Grass, June Grass, Spear Grass, Smooth Stalked Meadow Grass.

HISTORY.—Kentucky Blue is a native grass of Europe and Asia. It is one of the most widely distributed and most valuable of the grasses grown in America. The name given is used to distinguish it from Canadian Blue grass, and also because of the famous blue grass regions of the State of Kentucky.

BOTANICAL DESCRIPTION.—This grass is a long-lived perennial, having extensive creeping root stalks. Its root system and its hardiness make it one of the most persistent of grasses. The inflorescence is a panicle, pyramidal in shape and more widely spreading than Canadian Blue grass.

HABITS OF GROWTH.—Kentucky Blue becomes established after seeding comparatively slowly but, after establishment, is one of the earliest grasses in reaching maturity, being several days earlier than Orchard grass. Unlike Canadian Blue grass, which produces heads throughout the season, it heads only once. It produces a very thick uniform sod and is capable of crowding out most other grasses and even weeds. As an enemy to alfalfa, it is only surpassed among cultivated grasses by Canadian Blue grass.

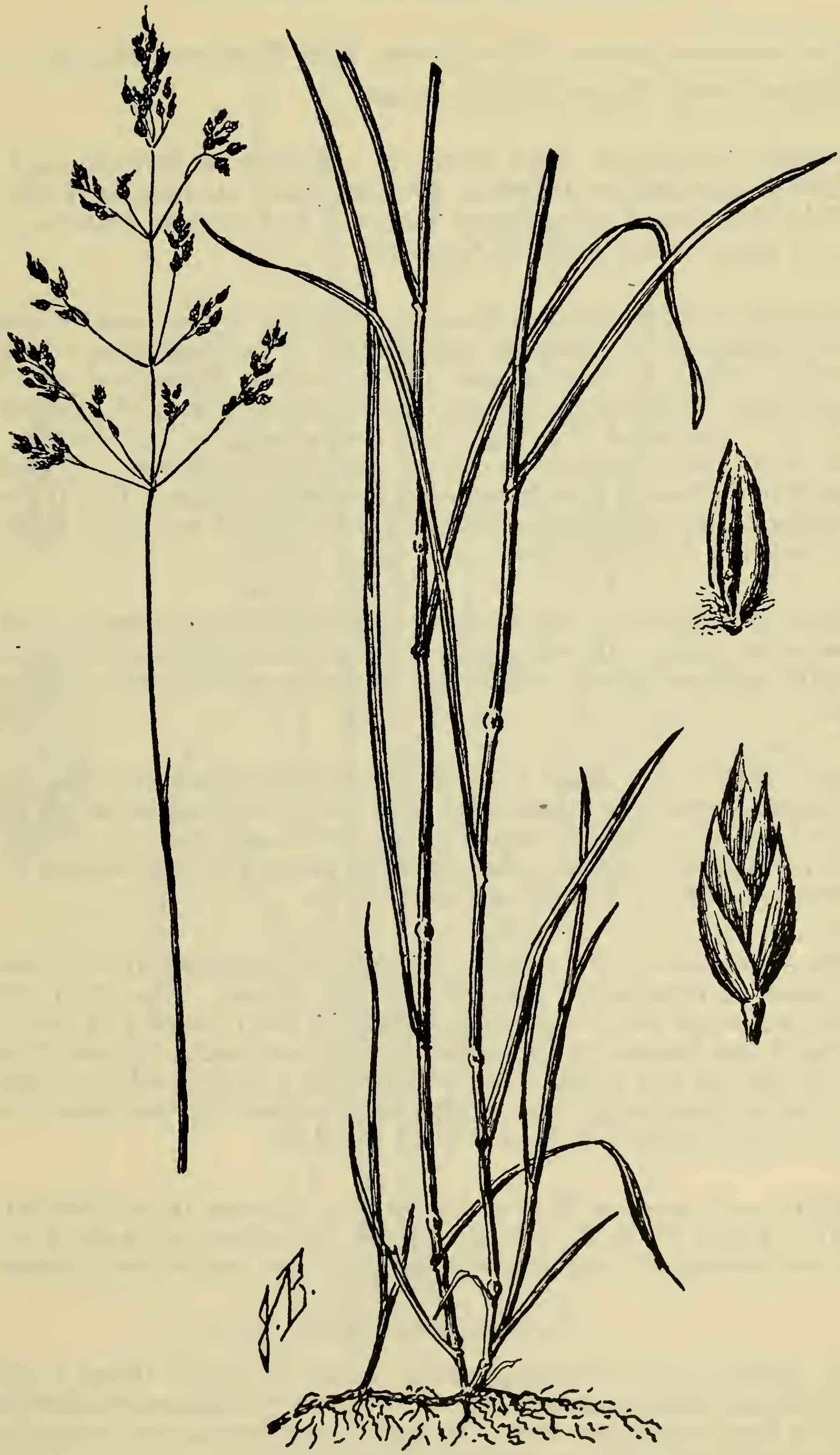
SOIL.—Kentucky Blue gives good results on a wide range of soils. Rich clay loam soils, over limestone formations, which do not suffer from drought in summer are the most suitable. This grass gives only fair results on sandy and on heavy clay soils.

SEED.—The seed, which is harsh to the touch, is awnless and of a medium brown color. In length it averages about one-eighth of an inch. The keel and the edges of the seed are covered with very fine silky hairs. Harvesting of seed should be commenced when the panicles have turned yellow in color. A large amount of the commercial seed is produced in the blue grass region of Kentucky. The weight per bushel is 14 pounds.

SEEDING.—It frequently happens that the germination of the seed is injured by heating in the process of curing and emphasis should be put on the advisability of germinating the seed before sowing. About 25 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

This grass is grown both for hay and pasture and as an ingredient in lawn mixtures. It produces a small amount of hay of good quality. The feeding value and palatability of Kentucky Blue grass hay is equalled by few grasses. The best hay is produced if the grass is cut when in bloom. As a pasture grass it ranks high, its palatability for this purpose being excelled by few other cultivated grasses. Kentucky Blue grass starts growth early in the spring and gives a fairly large amount of pasture throughout seasons of sufficient rainfall. Its chief weakness as a pasture grass lies in its inability to stand hot, dry summers. It forms a close compact turf which enables it to stand a large amount of tramping and close grazing without injury. Kentucky Blue is used as a basic grass in lawn mixtures. The formation of a fine close turf, its ability to stand tramping and close cutting gives it a position for this purpose unrivalled by any other grass.



Kentucky Blue Grass
(*Poa pratensis*)

Canadian Blue Grass (*Poa compressa*).

Other common names: Wire Grass, Flat Stemmed Meadow Grass, Canada Blue Grass, Virginia Blue Grass.

HISTORY.—Canadian Blue Grass is a native of Europe and Asia. It was first discovered in America, growing near Quebec, in 1792. It is now widely distributed throughout southern and central Ontario, and is common in many other parts of Canada.

BOTANICAL DESCRIPTION.—Canadian Blue is a perennial grass with extensive underground creeping root stalks. The flowers are arranged in a panicle which is shorter and not so widely branched as that of Kentucky Blue. The stems, which seldom reach a height greater than two feet, are flattened in shape and knee bent at the joints. This flattened stem characteristic is one of the chief points of difference in distinguishing between this grass and Kentucky Blue. The leaves are few, varying from one to three inches in length and are wiry in texture. In color they are a bluish green.

HABITS OF GROWTH.—This grass reaches maturity several days later than Kentucky Blue. It will stand very unfavorable conditions of soil and climate without injury and is one of the most difficult of grasses to eradicate.

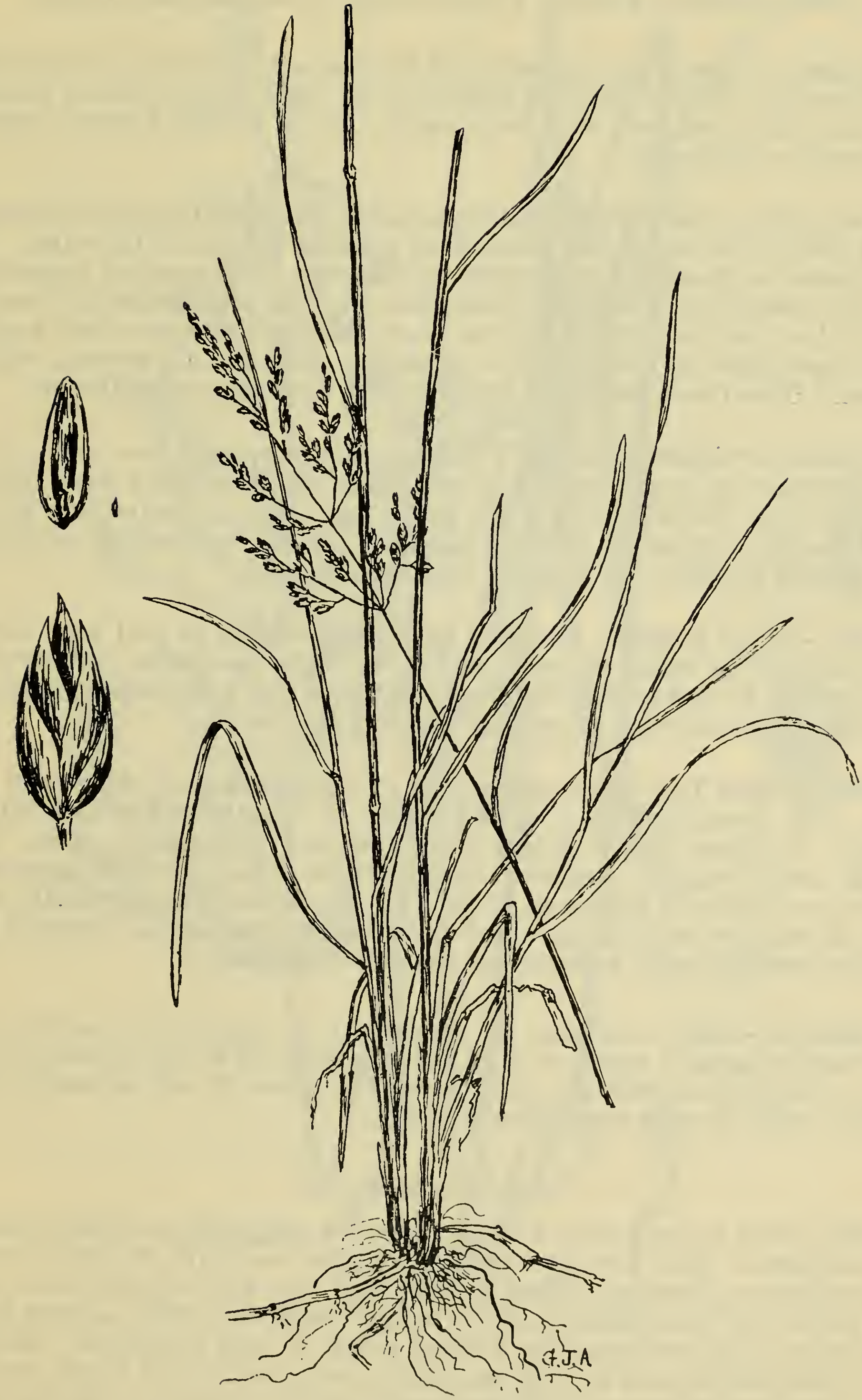
SOIL.—While this grass is very commonly found growing on poor soils, especially gravelly loam soils, it gives good results on clay loams providing they are not too wet. Soils which are poor in quality and deficient in moisture, where most other grasses will not thrive, provide an economic place for Canadian Blue Grass.

SEED.—The seed very closely resembles Kentucky Blue grass, and is often used to adulterate the seed of this grass. The chief point of difference between these two grass seeds are the presence of less prominent veins in the lemma of Canadian Blue grass seed. When grown for seed, it should be cut when the panicles are a deep yellow. The seed of this and of Kentucky Blue grass is threshed in the same way as Timothy. The weight per bushel is 14 pounds.

SEEDING.—Canadian Blue grass usually appears in cultivation spontaneously. From 20 to 25 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

The chief use of Canadian Blue grass is under those conditions where Kentucky Blue does not thrive. It is very little grown for hay because of its light yield per acre. In permanent pasture mixtures, it produces pasture later in the season than Kentucky Blue and of only slightly inferior quality. Like Kentucky Blue grass, it is well able to stand tramping and close grazing, and in this condition is more palatable to stock. It is frequently sown in lawn mixtures, and for this purpose is especially valuable on gravelly and stiff clay soils.



Canadian Blue Grass
(*Poa compressa*)

Red Top Grass (*Agrostis alba*).

Other common names: Fiorin Grass, Creeping Bent Grass.

HISTORY.—Red Top is a native of Europe and Asia and, it is thought, also of some of the countries of Northern Africa. In America it has been cultivated for over one hundred years. It is a well-known grass in many parts of Ontario.

BOTANICAL DESCRIPTION.—It is a hardy perennial grass with smooth erect growing stems, which sometimes reach a height of four feet. The root system is shallower than that of Timothy. In general appearance Red Top resembles Kentucky Blue, but may be distinguished from this grass by the purple color of the panicles, their wider branching and also by the fact that in Red Top the spikelets are one flowered, while in Kentucky Blue there are from three to five flowers in a spikelet.

HABITS OF GROWTH.—Red Top commences growth late in the spring but continues to grow until late autumn. It is several days later in blooming than Timothy, and is not at its best when included in a mixture with Timothy and other grasses for hay. Red Top usually provides a good second growth. It is quite resistant to cold.

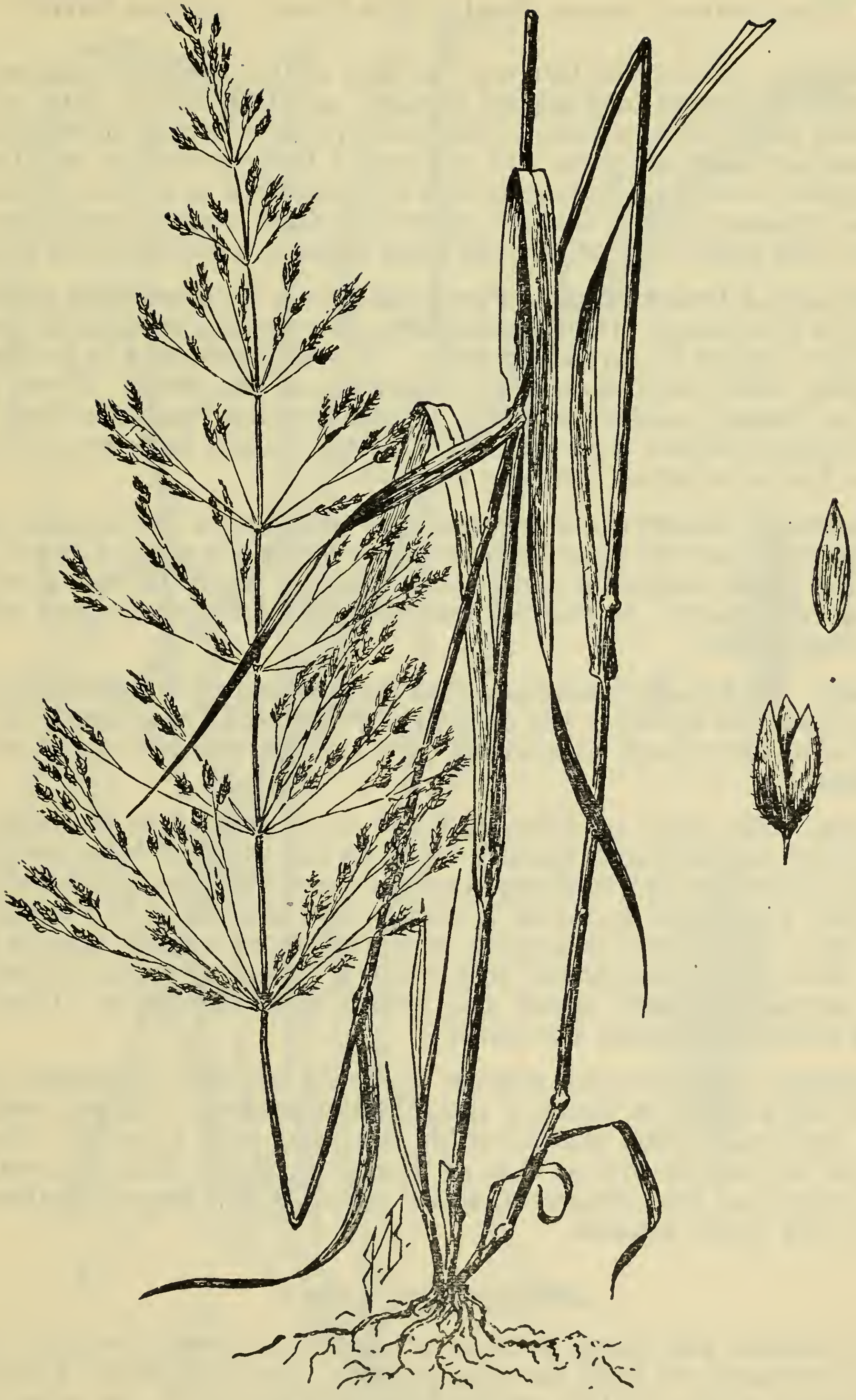
SOIL.—This grass is adapted to a wide range of soil and climate. It thrives best in moist or even wet soils. The moisture content of the soil seems to be a greater deciding factor in the successful growing of this grass than the type of soil on which it is grown.

SEED.—Red Top grass seed is one of the smallest of cultivated grass seeds. It is from 1-32 to 1-16 of an inch in length and somewhat boat shaped. In color it is a glossy light red and is without awns. Commercial seed usually contains considerable chaff, which lessens its weight per bushel. The seed should be cut when it shells easily in the hand. It may be readily threshed in the same manner as Timothy seed. The legal weight is 14 pounds per measured bushel.

SEEDING.—Red Top may be seeded in the spring of the year with good results, using a nurse crop of cereal grain. Twenty pounds of good seed is sufficient to sow an acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

This grass is grown for hay and pasture and also as an ingredient in lawn mixtures. Red Top hay, which weighs heavy for its bulk, is inferior in quality to Timothy. On wet soils, Red Top will outyield most of the other cultivated grasses for hay. On clay loam soils with a good supply of moisture, it is an excellent bottom grass in hay mixtures. Red Top makes sod quickly and nearly equal in quality to that of Kentucky Blue grass. Pasture mixtures, both temporary and permanent, when sown on low wet lands, should always include Red Top as one of the grasses sown. It gives its best results in lawns when it is sown thickly and is closely mowed. The individual plants of Red Top show almost as much variation in characteristics as those of Orchard grass, and much improvement is possible by selection.



Red Top Grass
(*Agrostis alba*).

Perennial Rye Grass (*Lolium perenne*).

Other common names: English Rye Grass, Common Darnel.

HISTORY.—Perennial Rye was the first of the perennial grasses to be grass was cultivated in England as early as 1677, which date is many cultivated as a pure culture. There are records which show that this years earlier than we have any record of the cultivation of Timothy. In European countries, Perennial Rye is considered to be one of the most valuable grasses and is widely grown in short rotation mixtures. In Ontario, this grass has not usually been found a profitable one to grow.

BOTANICAL DESCRIPTION.—Perennial Rye is a low growing grass lasting only a few years. It has indications of creeping root stalks and the plants often grow in spreading tufts. The inflorescence is in the form of a spike, with the spikelets set edgewise on the stem. These stems, which in Ontario seldom reach a height greater than two feet, grow erect and are slender and smooth. The leaves are dark green in color and are folded together when in the bud.

HABITS OF GROWTH.—Perennial Rye produces a low strong growth the first year, and its maximum growth during the second year. Even under the most favorable conditions, it is not likely to last more than three or four years. It reaches maturity about the same time as Kentucky Blue grass.

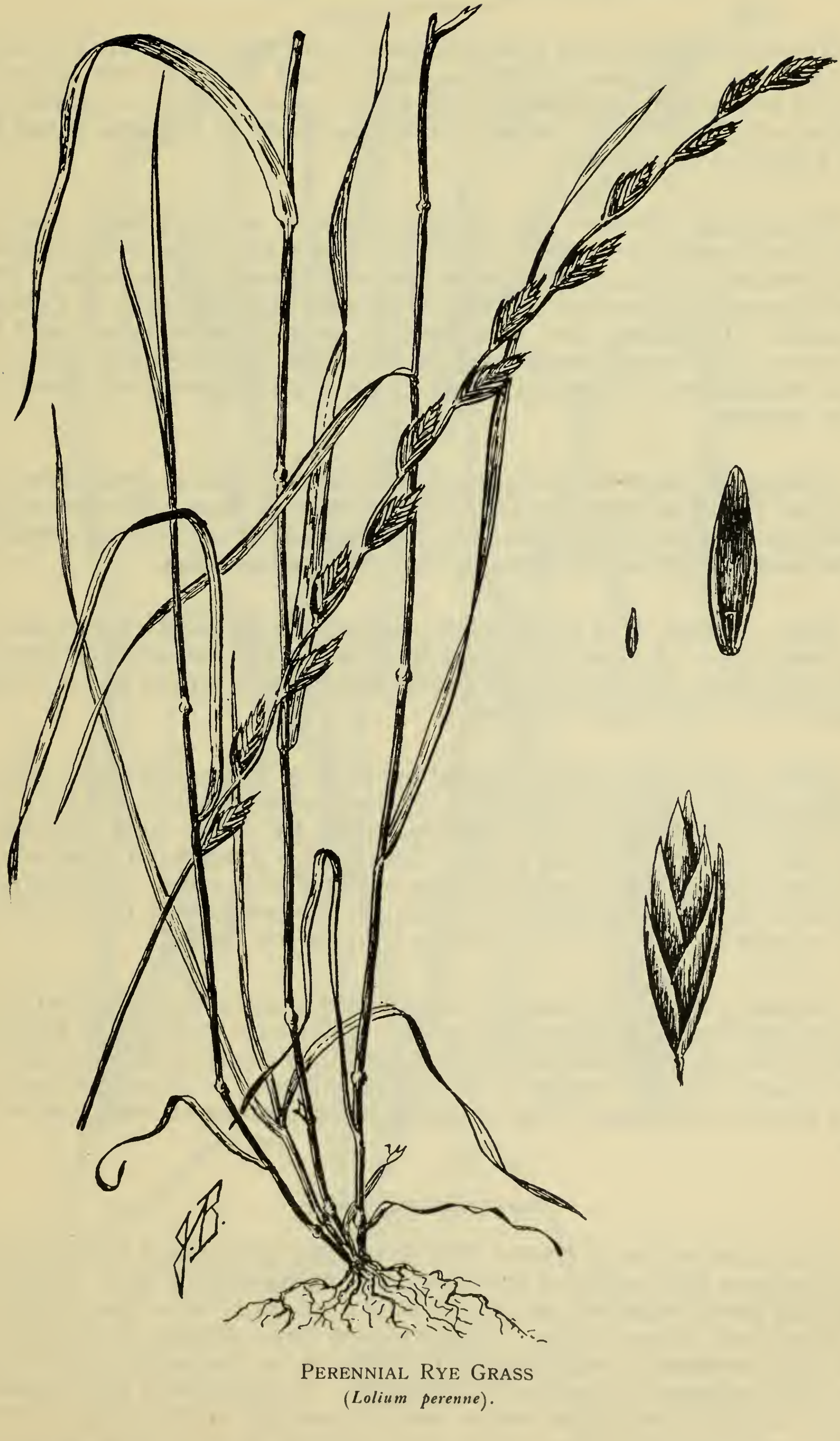
SOIL.—Rich moist loams and clay loam soils and comparatively mild climates are best suited to the growth of Perennial Rye grass. Soils with excessive moisture and poor sandy soils are not well suited for growing this grass.

SEED.—The seed of Perennial Rye is of a light brown color and shows more lustre than is usually found in the seeds of Meadow Fescue. In size and shape and in being awnless these two seeds resemble each other, but Perennial Rye seed is flatter and blunter at the ends. Perennial Rye is one of the largest seed producers among grasses. The seed is taken from the second crop when it becomes tough and leathery, which period is usually about one month after flowering. Good seed weighs about 25 pounds per bushel.

SEEDING.—Where the winters are mild enough, Perennial Rye is sown in the autumn to insure a crop the next season. Spring sown seed rarely produces a crop worth cutting the same year as sown. The seed is almost as easy to sow as that of Timothy. From 25 to 30 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

In Europe and those sections of America where Perennial Rye is grown, it is used for both hay and pasture. Its chief value, however, is as a pasture grass. When grown for hay it should be cut when in full bloom, and is cured in the same manner as Timothy. On account of the rapidity with which it becomes established, it is used in temporary pastures, permanent pastures and even in lawns. In permanent pastures it provides pasture during the period when the other and more valuable grasses are becoming established. It stands tramping and close cutting without injury. Its feeding value is inferior to that of Timothy.



Perennial Rye Grass
(*Lolium perenne*).

Italian Rye Grass (*Lolium multiflorum*).

HISTORY.—This grass is said to have been first cultivated in Northern Italy. It has been grown in France and England for about one hundred years and is considered of more value in these countries than elsewhere in Europe. In Ontario and other parts of Canada, it has been little grown in cultivation.

BOTANICAL DESCRIPTION.—Italian Rye is a short-lived perennial which considerably resembles Perennial Rye grass. The inflorescence is in the form of a spike with the spikelets set edgewise on the stem. These spikelets contain a greater number of flowers than do those of Perennial Rye grass. The stems are more slender, usually grow taller, and have the upper part more roughened than those of Perennial Rye. The leaves, which are of a bright green color, are comparatively broad and soft in texture.

HABITS OF GROWTH.—Italian Rye grass is even shorter-lived than Perennial Rye, few plants living after the second year. This grass starts growth early in the spring, reaches maturity early, and, where conditions are favorable, may be cut three or four times in a season.

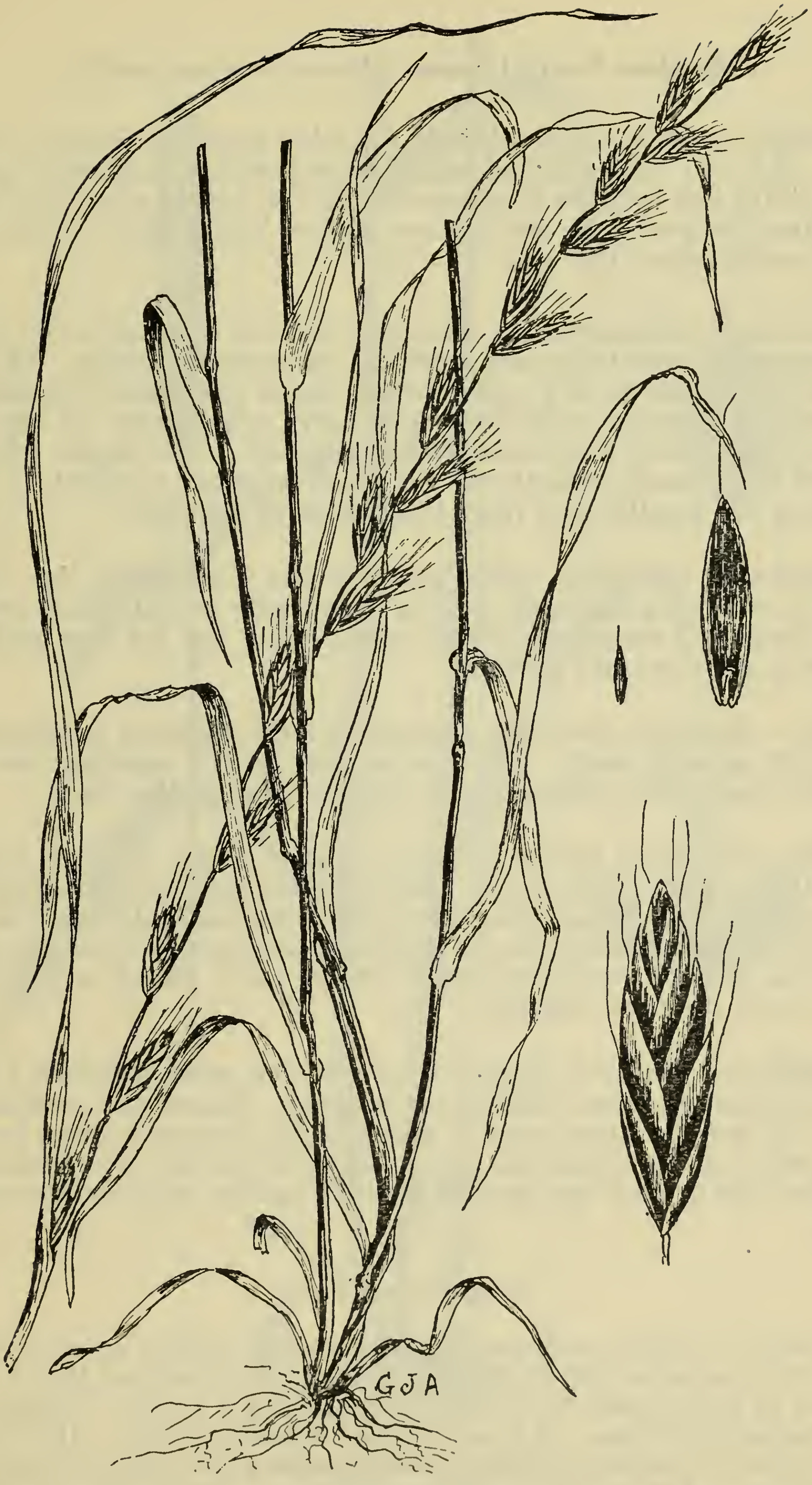
SOIL.—Italian Rye gives good results on rich sandy loam and rich clay loam soils. A good supply of lime in the soil favors its growth. It is not suited for growing on poor soils and on soils where water remains stagnant for any length of time.

SEED.—The seed much resembles that of Perennial Rye, but may be distinguished from the latter by its long slender awn, and its blunter and flatter appearance. It is also somewhat lighter in color and has less lustre than the seed of this grass. Italian Rye grass seed is usually cut in the late dough stage, as it shatters badly if over-ripe. Like Perennial Rye, it is a large seed yielder and is just as easily harvested and threshed. Seed weighs from 20 to 25 pounds per measured bushel.

SEEDING.—In mild climates fall seeding is usually considered to give the best results with Italian Rye grass. In Ontario fair results have been obtained where the grass has been seeded in the spring of the year along with a nurse crop of barley or of spring wheat. It is more often sown alone than in mixtures, when as much as 35 pounds of seed is sown per acre.

Agricultural Value.

The chief value of Italian Rye grass lies in its rapid growth and in the quickness with which it recovers after being cut for hay. Where the grass has been irrigated and where liquid manures have been applied, it has produced large yields. Experiments have shown, however, that, under the average conditions of Ontario, it is decidedly less valuable than such grasses as Timothy or Orchard. It produces a fair amount of pasture early in the spring and a medium amount of hay about the same quality as Perennial Rye. The hay should be cut when the plants are in full bloom and may be cured in much the same way as Timothy.



Italian Rye Grass
(*Lolium multiflorum*).

Meadow Foxtail Grass (*Alopecurus pratensis*).

HISTORY.—Meadow Foxtail is a native grass of Europe, Asia and Africa. It is one of the oldest and most commonly cultivated grasses in Great Britain and in other European countries having a moist climate. It is considerably grown in the Eastern United States and in some parts of Central and Eastern Canada.

BOTANICAL DESCRIPTION.—Meadow Foxtail is a long-lived perennial which grows in loose tufts and produces many basal leaves. The inflorescence is in the form of a spike which much resembles Timothy. The spikelets are covered with long soft hairs which give to the spike a softness to the touch not possessed by Timothy. The stems, which grow erect and are smooth, usually do not reach as great a height as Timothy. The leaves are smaller and finer than those of Timothy.

HABITS OF GROWTH.—This grass is the earliest of the cultivated grasses in reaching maturity and is frequently in full head before the first of June. It recovers quickly after being cut for hay and usually produces a good second growth.

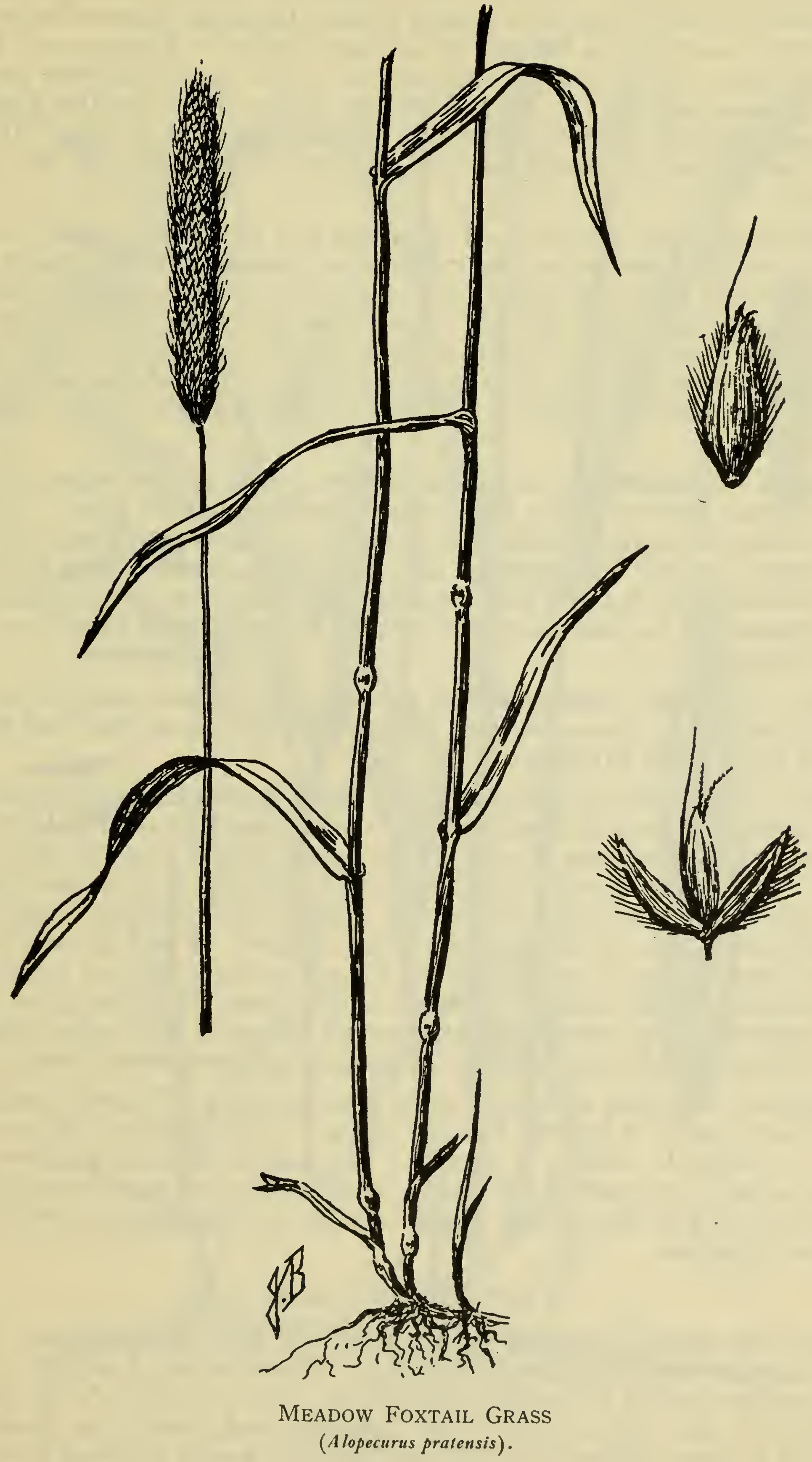
SOIL.—Rich clay and clay loam soils with plentiful supply of moisture suit its growth best. It is not partial to dry weather nor to soils where the water lies stagnant the greater part of the time.

SEED.—The seed varies in color from a silvery grey to a straw, is comparatively short, soft, fluffy and possesses fine medium-length awns. It ripens early but rather unevenly, which makes it difficult to harvest and to cure. The unevenness in maturing seed seems to be the explanation of the lack of vitality in much of the seed. Seed weighs about 5 pounds per measured bushel.

SEEDING.—Meadow Foxtail is one of the most difficult grasses to sow and obtain an even distribution of seed. Successful seeding is only possible where the grass seed is mixed with the grain sown as a nurse crop or with sand or other soil. From 20 to 25 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Meadow Foxtail produces hay of a quality nearly equal to Timothy, but is a much smaller yielder per acre. Owing to the fact that it requires from two to three years to become established it is very seldom sown in short rotation mixtures. It is cut for hay when in bloom. Its chief value lies in its use in permanent pasture mixtures where its earliness gives it a value possessed by no other cultivated grass, as it provides considerable pasture at a period when stock have little other pasture to graze upon.



Meadow Foxtail Grass
(*Alopecurus pratensis*).

Awnless Brome Grass (*Bromus inermis*).

Other common names: Brome Grass, Smooth Brome Grass, Hungarian Brome Grass, Austrian Brome Grass, Russian Brome Grass.

HISTORY.—Awnless Brome, which is a native of Europe and western Asia, has been cultivated in Europe for about one hundred and sixty years. It was introduced into America about 1882 by the California Experiment Station and into Canada shortly after this date. It is now widely distributed throughout Canada and especially in the Prairie Provinces.

BOTANICAL DESCRIPTION.—This grass is a very long-lived perennial, and is one of the hardiest of the cultivated grasses. Its extensive system of creeping root stalks forms a firm deep sod which is difficult to break up. The panicle, which is large, spreading and drooping, becomes contracted after flowering. The spikelets, which are often nearly an inch long, turn a brownish red color with maturity. The stems are stout and smooth. The leaves, which are quite numerous, are long, broad and smooth.

HABITS OF GROWTH.—Awnless Brome grass grows slowly the first year and does not reach its full growth until the third year. After becoming established, it produces a fairly large amount of material early in the spring, during the summer and into late autumn. It is such an extensive stooler that the soil has been known to become sod bound, necessitating reseeding to maintain the yield. It matures a few days earlier than Timothy.

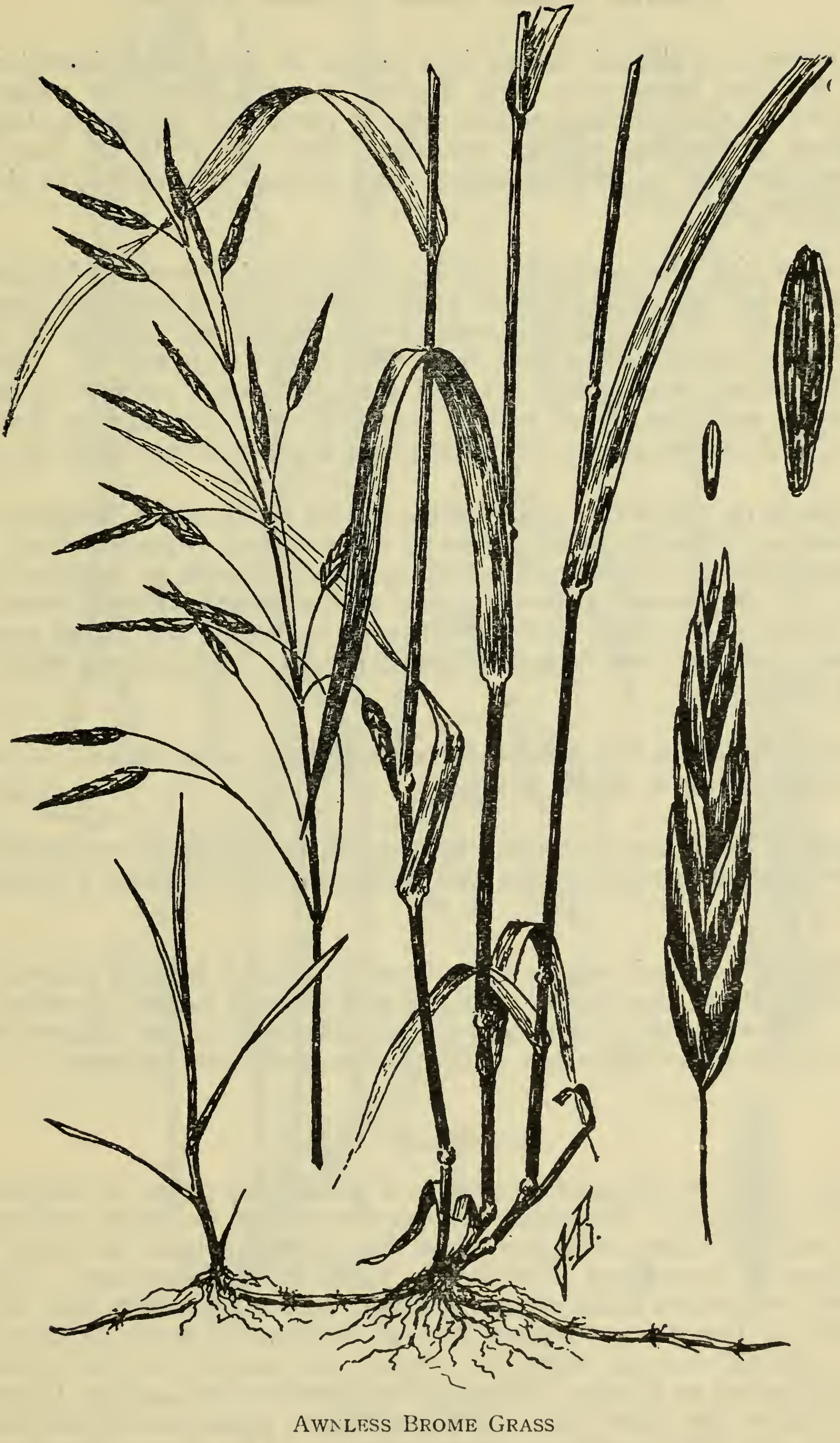
SOIL.—It seems best adapted to dry and rather poor soils, and is especially suited to those regions where the climate is cold and the rainfall light during the summer.

SEED.—The seed is light brown in color, about three-eighths to one-half of an inch in length, and in shape resembles that of Meadow Fescue. It differs from this grass, however, in being larger, flatter, and having blunter ends. Commercial seed is grown chiefly in the north-western States, Manitoba and Saskatchewan. This seed usually contains considerable quantities of chaff and broken stems. When grown for seed, Awnless Brome should be cut when the spikes have turned brown. The seed is less likely to shatter through being over-ripe than that of most other grasses. It is harvested and cured in much the same manner as cereal grains. Good seed weighs 14 pounds per measured bushel.

SEEDING.—Spring seeding, using a nurse crop of cereal grain, gives good results with Awnless Brome grass. This method of seeding is especially suitable where it follows dry autumns and winters with a small amount of snowfall. Fifteen pounds of good seed is sufficient to sow an acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Awnless Brome grass is grown for both hay and pasture. It is resistant against both cold and drought. When grown for hay, it should be cut just as soon as it reaches full bloom. The quality of hay produced in Ontario is not equal to that of Timothy and, owing to greater leaf growth, it is more difficult to cure and is more easily injured by unfavorable weather conditions than the hay of this grass. It is of greater value for pasture than for hay. The pasture is readily eaten by stock and it stands close tramping well. This grass has less value for Ontario conditions than either Timothy or Orchard Grass.



AWNLESS BROME GRASS
(*Bromus inermis*).

Fringed Brome Grass (*Bromus ciliatus*).

HISTORY.—Fringed Brome is a native of the North American continent, but has been very little grown in cultivation. In experiments conducted at Guelph, extending over a period of six years, this grass has given promising results, standing third in yield of hay among fourteen varieties of grasses tested, and giving returns above the average for pasture.

BOTANICAL DESCRIPTION.—It is a long-lived perennial having short root stalks and growing in loose tufts. The panicle is broad, spreading and drooping. The spikelets, which are nearly all carried at the end of the panicles, are long and from five to nine flowered. The stems are tall, rather slender and covered with stiff hairs on the lower parts. The leaves are broad and soft in texture, being covered on both sides with soft, short hairs. In color the grass is a decidedly light green.

HABITS OF GROWTH.—This grass is less hardy than Awnless Brome and greater difficulty is experienced in obtaining a good stand. When once established, however, it maintains itself almost as well as Awnless Brome. It commences growth slowly in the spring and recovers slowly after being cut for hay. Fringed Brome is one of the latest grasses in reaching maturity and is ready to cut for hay about three weeks later than Timothy.

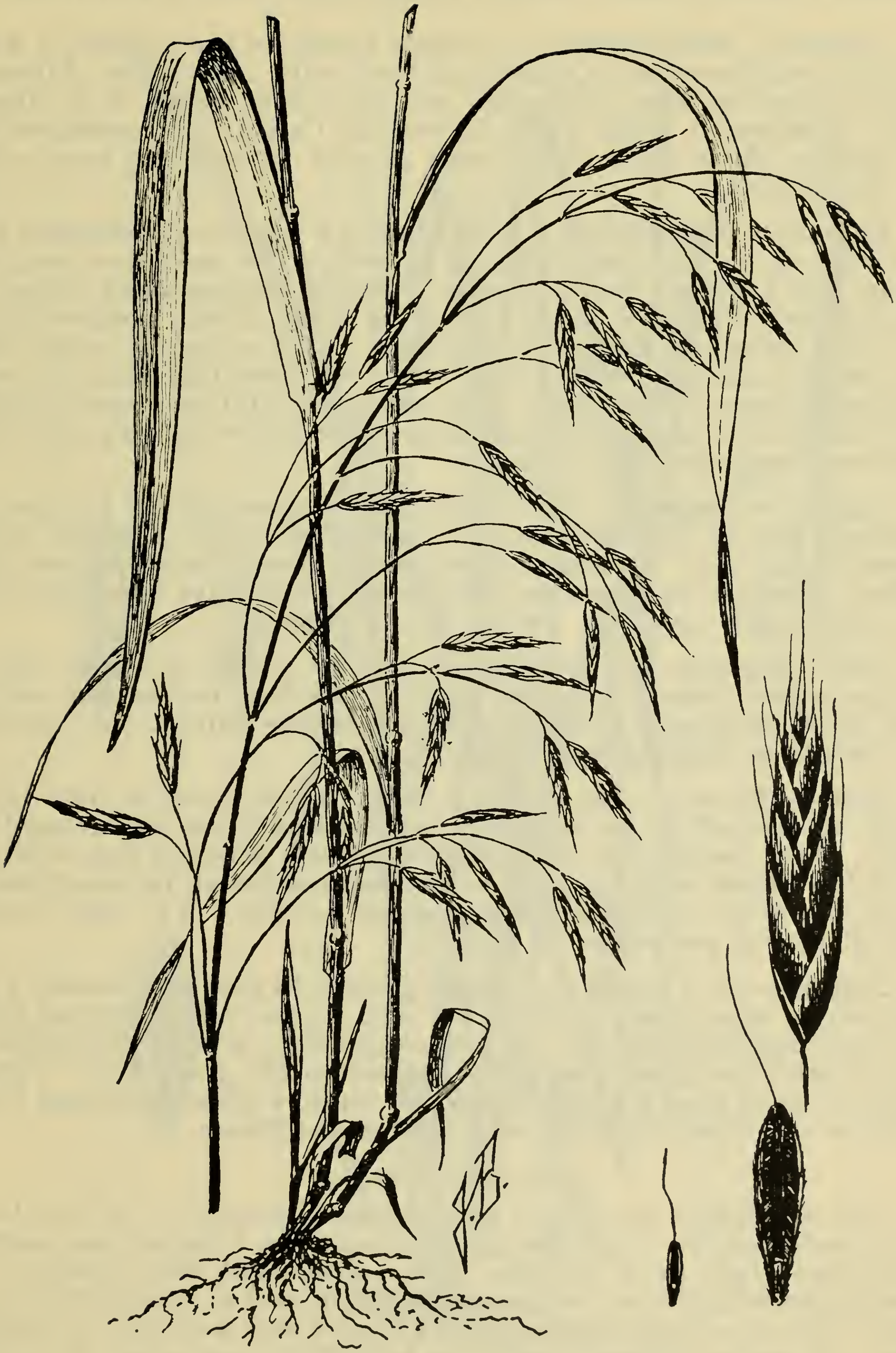
SOIL.—It gives the best results on rich moist soils and is well adapted to growing in shady places.

SEED.—With the exception that it is hairy, it much resembles Awnless Brome seed in appearance and weighs about the same per measured bushel.

SEEDING.—Good results have been obtained when Fringed Brome has been sown in the spring with a nurse crop of barley or other cereal grain. Fifteen pounds of good seed is sufficient to sow an acre when it is not seeded in combination with clovers and other grasses.

Agricultural Value.

The value of Fringed Brome as a cultivated grass is not definitely known in Ontario. Experiments, conducted at Guelph, indicate that it is worthy of more attention than has hitherto been given to it. In these tests, it surpassed Timothy in yield of hay per acre. The hay, however, was more difficult to cure and was coarser and less palatable than that of Timothy. Fringed Brome, in order to make its best quality of hay, should be cut when it reaches the period of full bloom. In tests conducted at Guelph, where it was grown for pasture, it produced slightly more per acre than Awnless Brome grass and stood tramping equally well. The quality and palatability of the grass, however, was inferior to that of Awnless Brome.



Fringed Brome Grass
(*Bromus ciliatus*).

Western Rye Grass (*Agropyron tenerum*).

Other common names: Slender Wheat Grass, Bald Wheat Grass.

HISTORY.—Western Rye is a native American grass which is widely distributed throughout Canada and the Pacific coast states. Although Western Rye has been cultivated less than fifty years, it is already highly esteemed in many parts of western Canada. It combines hay and pasture value better than most grasses which have been under test at Guelph.

BOTANICAL DESCRIPTION.—This grass is a long-lived perennial with somewhat of a branching habit of growth. The roots are long and fibrous and have not the extensive, creeping, underground system of Couch grass. The inflorescence is in the form of long narrow spikes, and much resembles that of Couch grass. The spikelets, which have awn pointed glumes, differ from those of Perennial Rye by being attached flatwise to the stems. The stems grow tall and erect and are more slender than those of Couch Grass. The leaves are long and softer in texture than those of this grass.

HABITS OF GROWTH.—After seeding, this grass quickly becomes established, and in favorable seasons will often produce heads in the autumn of the year. It reaches its maximum growth the third year after sowing. Western Rye matures hay ten to twelve days later than Timothy and usually produces a good second growth.

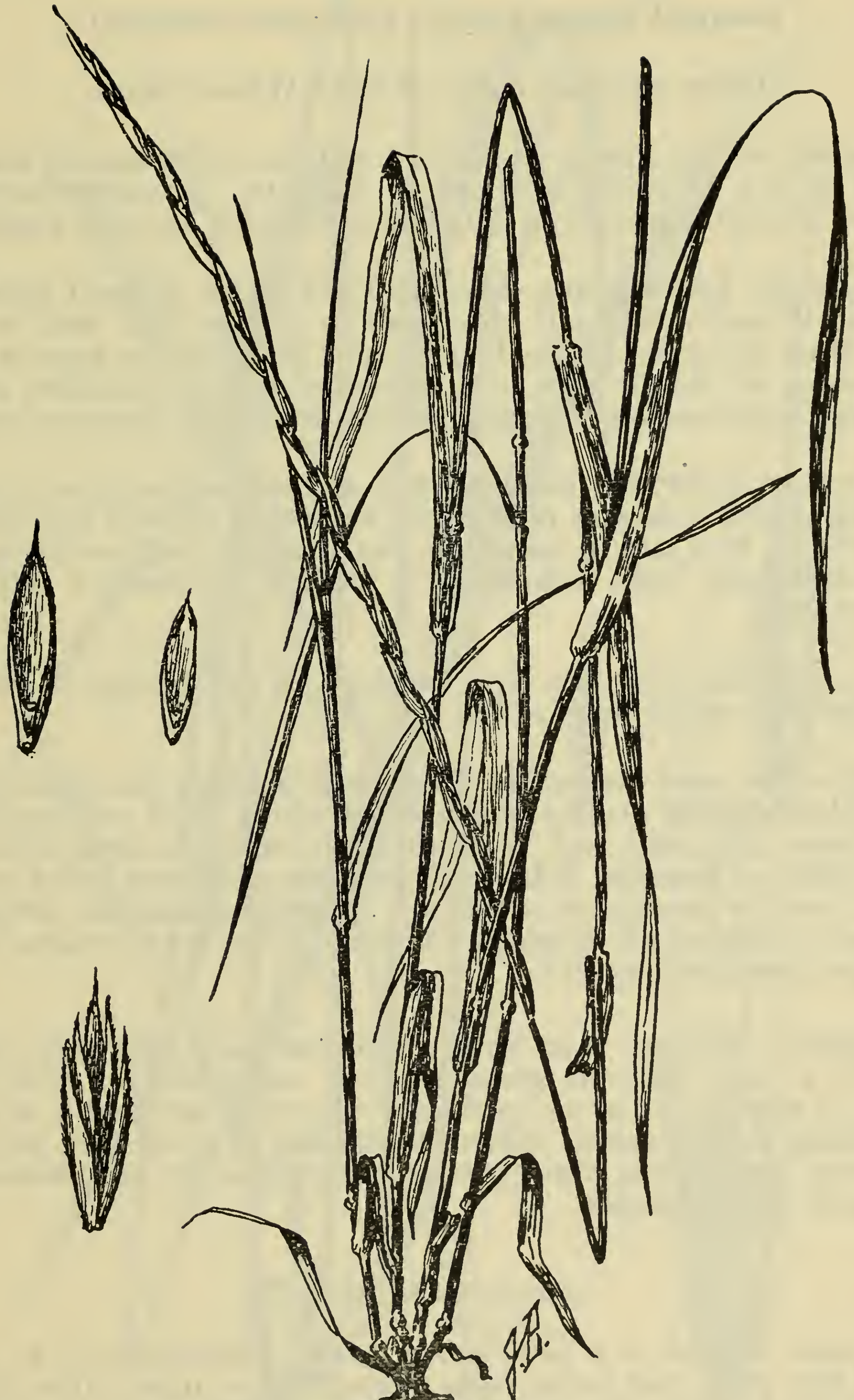
SOIL.—Western Rye grass does best on rather dry soils and in climates where there is a limited rainfall. Its deep root system enables it to stand prolonged drought without serious injury. It produces poor results on flooded land areas.

SEED.—The seed, which is of a bright straw color, is from three-eighths to one-half of an inch long and somewhat resembles small oat grain. These seeds have short straight awns. Western Rye, which is one of the easiest of the grasses to harvest and thresh for seed, should be cut when the spikelets become straw colored. The seed weighs about 20 pounds per measured bushel.

SEEDING.—It is one of the easiest grasses to sow, and usually gives good results when sown in the spring with a nurse crop of cereal grain. An even distribution of seed may be obtained by seeding broadcast by hand or with the grass seeder attachment on the grain drill. Fifteen pounds of good seed is sufficient to sow an acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Western Rye is one of the best grasses cultivated in its resistance to cold and drought. It produces good results for both hay and pasture when sown alone or in mixtures with clovers and other grasses. In variety tests, which were conducted at Guelph over a period of six years, it stood first in average yield of hay per acre and was third in pasture value. It makes its best quality of hay if cut just when the heads are fully out of the sheath. The quality of hay produced is not quite the equal of Awnless Brome. This grass, like Timothy and Orchard, is quite variable in its individual plants, showing great differences in height, in stooling qualities, in vigor of growth, and in color. Systematic plant selection provides the means of improving the value of Western Rye grass.



Western Rye Grass
(*Agropyron tenerum*).

Bearded Wheat Grass (*Agropyron caninum*).

Other common name: Awned Wheat Grass.

HISTORY.—This grass, which is a native of Europe, is now quite common in the Prairie Provinces of Canada. In experiments conducted at Guelph it has given only fair results for hay and pasture.

BOTANCIAL DESCRIPTION.—Bearded Wheat in general appearance resembles Western Rye, but is coarser in texture and may be distinguished from this grass by the long awn of its flowering glumes and the arrangement of the flowers in a one-sided spike. It often grows in tufts, sometimes reaches a height of three feet, and droops at maturity.

HABITS OF GROWTH.—Bearded Wheat commences growth slowly in the spring of the year and reaches its maximum growth the third year after sowing. It is late in maturing, reaching the hay condition two or three weeks later than Timothy. It usually produces a fairly good second growth.

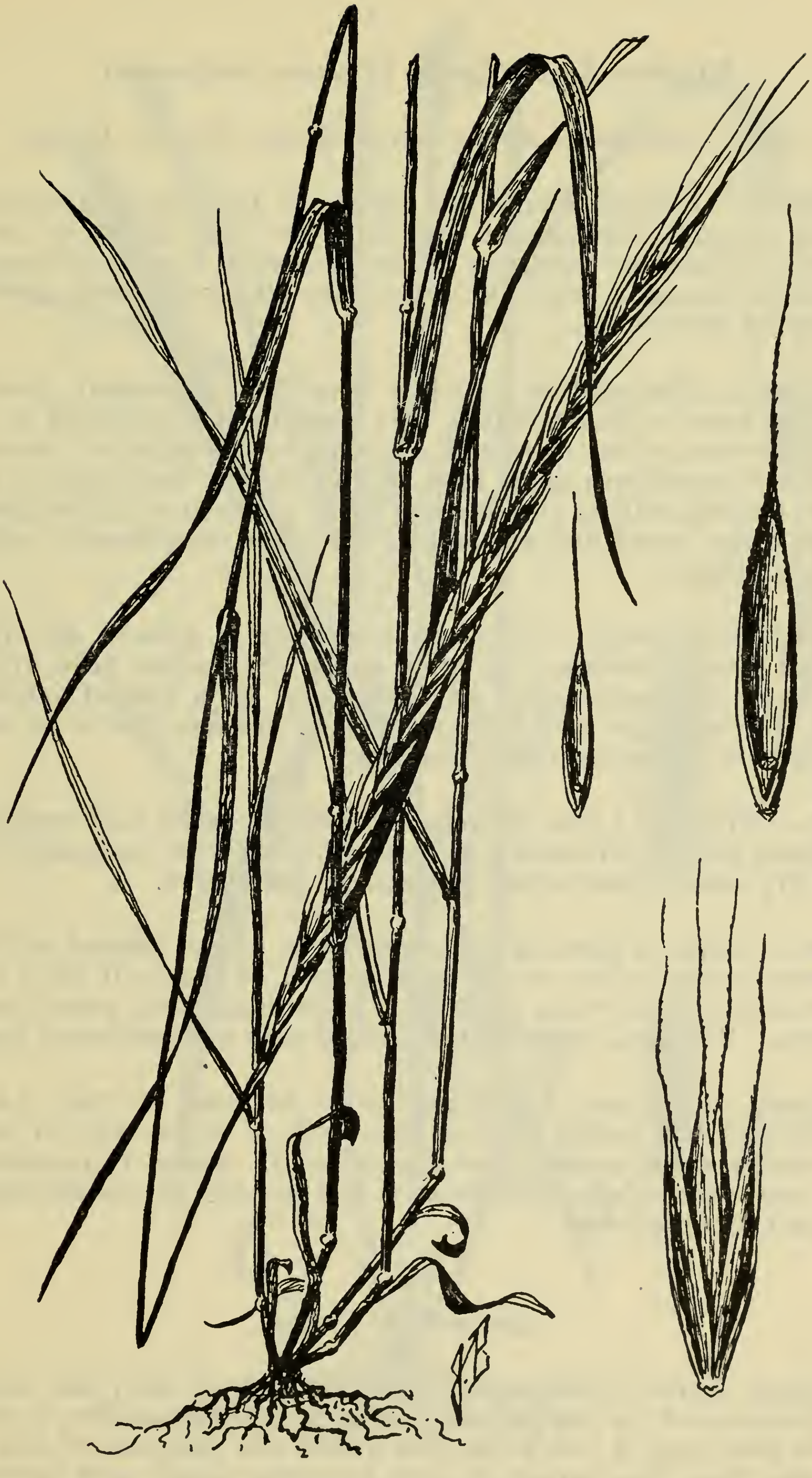
SOIL.—Unlike Western Rye grass, it is not partial to dry soils, but prefers rich moist loam soil.

SEED.—The seed resembles Western Rye grass, but is not quite so long and has slightly greater width. One of the chief points of distinction between this seed and Western Rye lies in the long stiff-awned characteristic of Bearded Wheat. This grass is seldom listed by seedsmen, but seed is sometimes obtainable in small quantities through the experiment stations of Western Canada. The seed weighs about 7 pounds per measured bushel.

SEEDING.—Because of its light weight and long stiff awns, Bearded Wheat is a very difficult grass to seed successfully. This is only possible by mixing the grass seed with the grain sown as a nurse crop or by mixing it with sand. About 15 pounds of good seed per acre is the amount used when the grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Bearded Wheat is a very hardy grass, standing cold as well as Western Rye grass, but being more susceptible to injury from drought. Although it has given fair yields of hay and fair results for pasture in experiments conducted at Guelph it is unlikely, on account of the difficulty of seeding it evenly, its lack of palatability and its general coarseness, that it will ever be much cultivated in Ontario.



Bearded Wheat Grass
(*Agropyron caninum*).

Virginia Lyme Grass (*Elymus virginicus*).

Other common names: Lyme Grass, Terrell Grass.

HISTORY.—Virginia Lyme is a native of the North American continent and is found throughout Canada from Nova Scotia to the Rocky Mountains. It is more common in the Maritime Provinces than in any other part of Canada. Very little attention has so far been given to the cultivation of this grass.

BOTANICAL DESCRIPTION.—It is a long-lived perennial grass with a tendency to grow in dense tufts. The flowers are produced in a spike-like inflorescence which is nearly as large as the spike of wheat. The stems, which sometimes grow to a height of four feet, have a purplish tinge, are smooth, rather slender and leafy to the top of the plant. The leaves are quite broad and abundant, the lower ones usually being dead at flowering time.

HABITS OF GROWTH.—Virginia Lyme starts growth slowly in the spring and usually does not produce much of a second crop after being cut for hay. It reaches the hay condition at a period intermediate between Western Rye and Fringed Brome grasses and is at least two weeks later in maturing than Timothy.

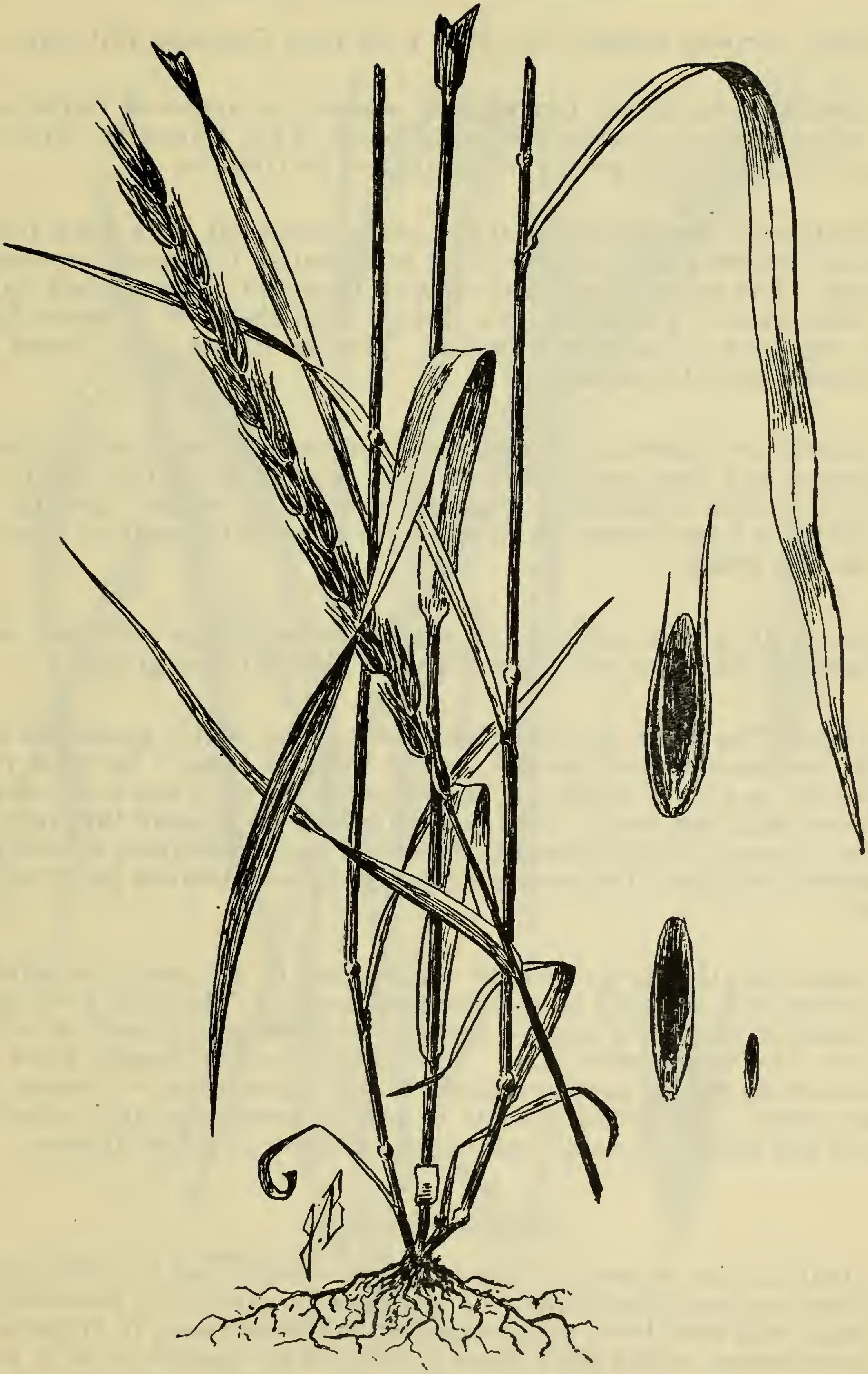
SOIL.—Virginia Lyme is quite adaptable in its soil requirements. It gives good results on moist loam soils and has been successfully grown on light dry soils where other grasses do not thrive.

SEED.—Virginia Lyme grass seed is one of the largest of the cultivated grass seeds, often reaching a length of one-half inch or more. It is very broad, with wide projecting smooth glumes, which have very short awns. The seed weighs about 12 pounds per measured bushel.

SEEDING.—It is not a difficult grass to sow. It may be seeded successfully in the spring of the year with a nurse crop of barley or other cereal grain or sown broadcast by hand. About 15 pounds of seed is sown per acre when this grass is not seeded in combination with clovers and other grasses.

Agricultural Value.

Virginia Lyme produces a large amount of hay, the quality of which, because of its coarseness and lack of palatability, is poor. It makes its best hay if cut when the heads are just out of the sheath. If left later than this period, it soon becomes woody and unpalatable. If used for pasture, it is usually not cut for hay. The best pasture results are obtained when the grass is pastured closely.



Virginia Lyme Grass
(*Elymus virginicus*).

Canadian Lyme Grass (*Elymus canadensis*).

Other common names: Nodding Wild Rye, Common Wild Rye.

HISTORY.—Canadian Lyme grass, which is a native of Canada and the United States, is common in some parts of the Canadian West, but, so far, has been little grown in cultivation in Ontario.

BOTANICAL DESCRIPTION.—It is a leafy perennial, with deep fibrous roots, and shows a decided tendency to droop as the grass approaches maturity. The spike is long and densely flowered, the spikelets having long bent awns. The stems are stouter than those of Virginia Lyme, but do not grow to so great a height. The leaves are short, broad and somewhat coarse in texture.

HABITS OF GROWTH.—Canadian Lyme grass starts growth slowly in the spring and does not reach its full growth until the third year. Under favorable conditions, it produces a better second growth than does Virginia Lyme grass. It reaches the hay condition about the same time as this grass.

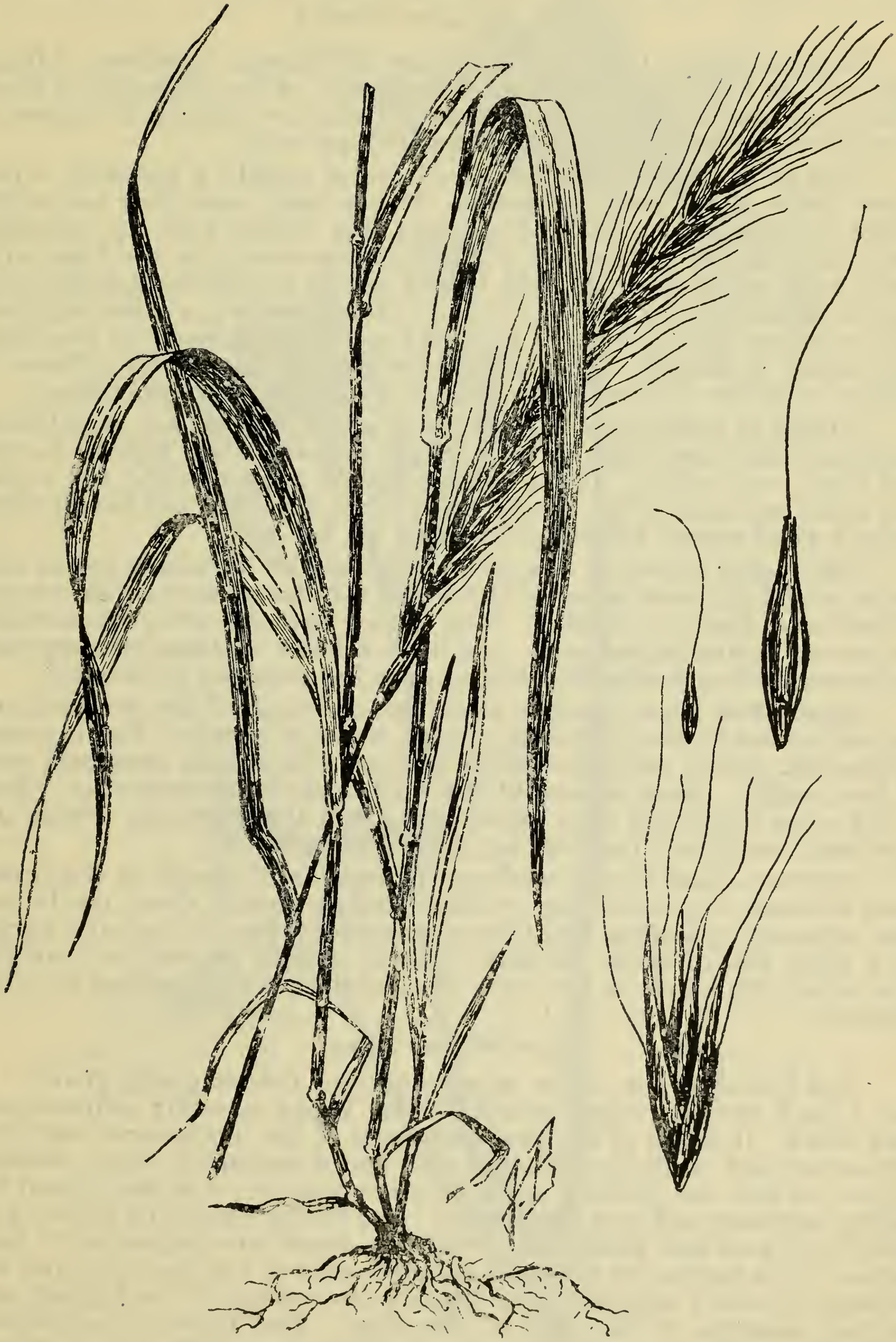
SOIL.—It is best suited to growing on sandy loam soils and is less adaptable to different soil types than is Virginia Lyme grass.

SEED.—The seed of Canadian Lyme grass, while about the same length, is more slender than the seed of Virginia Lyme. Its color varies from straw to a light brown. The glumes of the seed are hairy and the awns are long and bent. Seed is usually not obtainable through commercial sources. Small amounts, however, may sometimes be had from experiment stations. The seed weighs about seven pounds per measured bushel.

SEEDING.—Owing to its light weight and to the awn characteristic of the seed, it is difficult to sow the seed evenly. The most even stands are obtained when the grass is seeded with the grain used as a nurse crop or when mixed with sand. At Guelph, the best results have been obtained from spring sowing and the use of a nurse crop of barley or of spring wheat. About 15 pounds of seed is sown per acre when this grass is not seeded in combination with clovers or other grasses.

Agricultural Value.

Owing to the scarcity of seed, its low vitality and the difficulty of obtaining an even distribution of the seed in sowing, it is doubtful if this grass will ever be of much agricultural importance in Ontario. In the experiments which have been conducted at Guelph, over a period of six years, Canadian Lyme grass has given better results for pasture but less hay per acre than Virginia Lyme. The hay produced was of inferior quality to that furnished by Virginia Lyme grass. The best quality of hay of Canadian Lyme is obtained when the grass is cut early, soon after the heads are out of the sheath. The best pasture results are obtained when the grass is pastured at an early stage of growth.



Canadian Lyme Grass
(*Elymus canadensis*).

Common Red Clover (*Trifolium pratense*).

Other common names: June Clover, Meadow Clover, Broad-Leaved Clover, Meadow Trefoil.

HISTORY.—Red Clover is a native of Europe, northern Africa, Siberia, and south-western Asia. The history of its cultivation is much older than that of any of the grasses. There are records of its use as a cultivated plant at least two thousand years old.

BOTANICAL DESCRIPTION.—Red Clover is mainly a biennial, a few plants being short-lived perennials. It has deep branching tap roots, which enables it to withstand drought and which have an excellent mechanical effect on the soil. The inflorescence is in the form of a dense head, which is, when fully grown, nearly an inch in diameter, and may be bright red, or purple, in color. The flowers are cross-fertilized chiefly through the agency of bumble bees. The stems grow erect and vary much in height. The leaflets, which are larger than those of Alsike or White Clover, have distinct V-shaped white markings.

HABITS OF GROWTH.—In the year in which it is seeded, Red Clover produces little more than its root system and sufficient growth to protect itself over winter. In the second season, it reaches the hay condition from ten days to two weeks earlier than Timothy and usually produces a good second growth after being cut for hay.

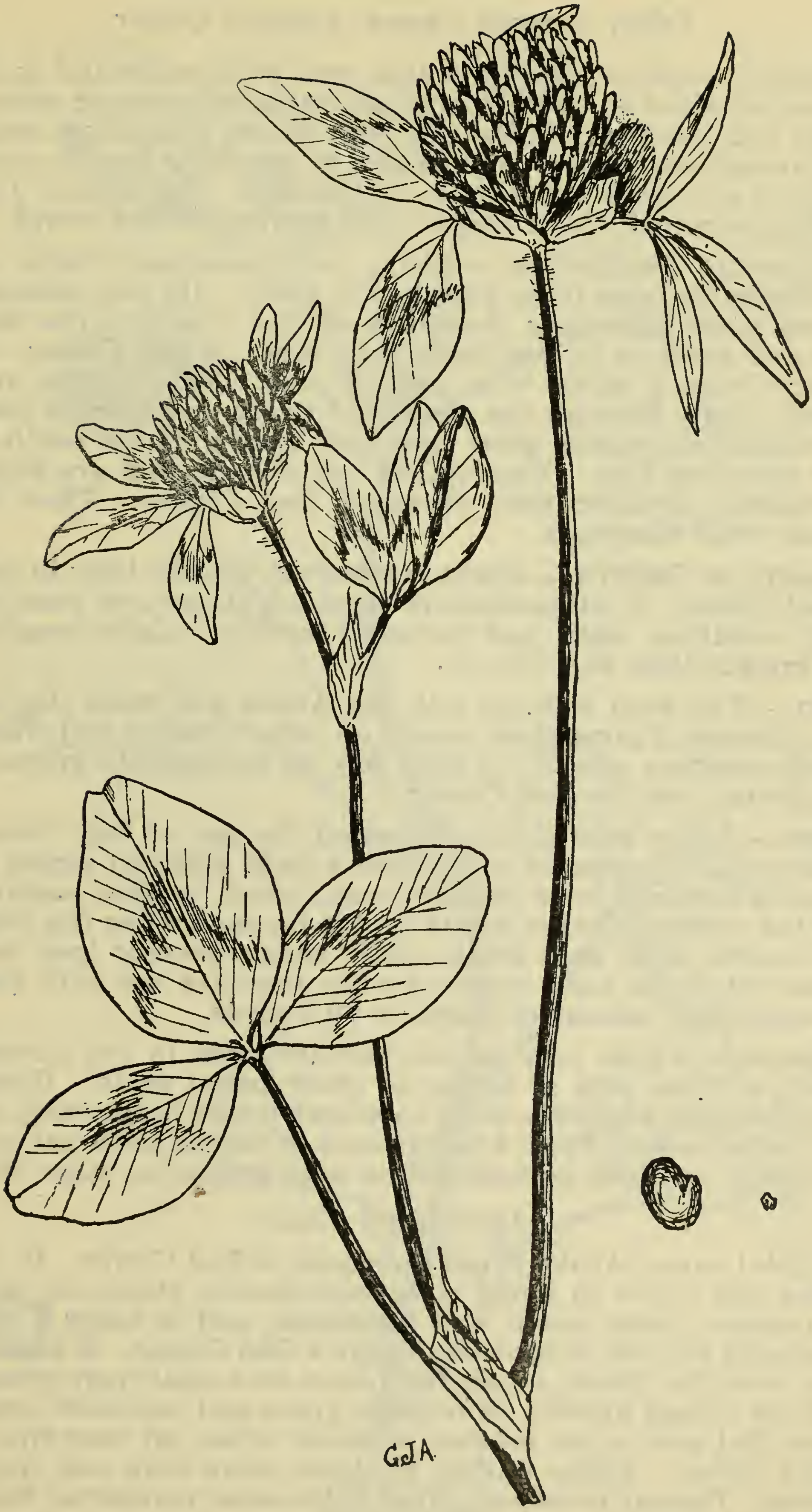
SOIL.—Red Clover is adapted to growing on various types of soil, the most suitable soils being well-drained clay loams with a fair amount of lime and plenty of humus. Red Clover does not grow successfully on poor or water-logged soils. An open subsoil is almost as necessary for successfully growing Red Clover as is the required surface soil.

SEED.—Red Clover seed is about one-sixteenth of an inch long and varies in color from a yellow to a dark violet or purple. The presence of deadish brown shrunken seeds indicates immature seed and seed of low vitality. Seed is usually obtained from the second crop, which is cut when the heads turn brown and when the stems are drying up. The legal weight is 60 pounds per measured bushel.

SEEDING.—Red Clover seed may be successfully sown in the spring with a nurse crop of barley or other cereal grain. Good results are also obtained by seeding Red Clover on winter wheat in the early spring on a fresh fall of snow. About 10 to 12 pounds of seed is sown per acre when this clover is not sown in combination with grasses or other clovers.

Agricultural Value.

Red Clover is one of the most important fodder plants grown. It has a high feeding value, especially for young growing animals and milk cows. It is one of the best improvers of the mechanical condition of the soil and is highly valuable as a green manuring crop. Besides its use for hay and pasture and as a green manure, it is also grown for soiling purposes and as a silage crop. Red Clover should be cut for hay when just past full bloom and when the heads are beginning to turn brown. The leaves are the most valuable part of the hay crop and the method of curing adopted should insure the saving of the highest percentage possible of this part of the plant. Red Clover is sometimes pastured the first autumn, but care should be taken that it is not pastured too closely, or too late in the season. Mammoth Red is an important strain of Red Clover. It is larger, coarser, and several days later in maturing than Common Red Clover. Unlike Common Red Clover, it only produces one good cutting of hay in a season.



RED CLOVER
(*Trifolium pratense*).

Alsike Clover (*Trifolium hybridum*).

Other common names: Swedish Clover.

HISTORY.—Alsike Clover, which was first cultivated in Sweden, about one hundred and sixty years ago, takes its common name from a parish in that country. In the last sixty years, it has been extensively grown throughout Europe. In Canada, its growth is largely confined to the eastern provinces and chiefly to Ontario. The city of Toronto is one of the principal Alsike Clover seed markets of the world.

BOTANICAL DESCRIPTION.—Alsike is a perennial which, on good soils, frequently lasts from four to six years. Its root system is less deep and more branching than that of Red Clover. The heads are smaller and grow on longer stalks than those of Red Clover. In color they vary from a white to a pinkish rose. The flowers are cross-fertilized chiefly through the agency of honey and bumble bees. The stems, which are smooth, grow erect and usually do not reach a height greater than two feet. The leaflets are smooth, and are shorter and comparatively broader than those of Red Clover. They have no V-shaped white markings.

HABITS OF GROWTH.—Alsike commences growth later in the spring than Red Clover. It blossoms later than this clover and does not reach the hay condition until just before Timothy. Alsike produces less second growth than Red Clover.

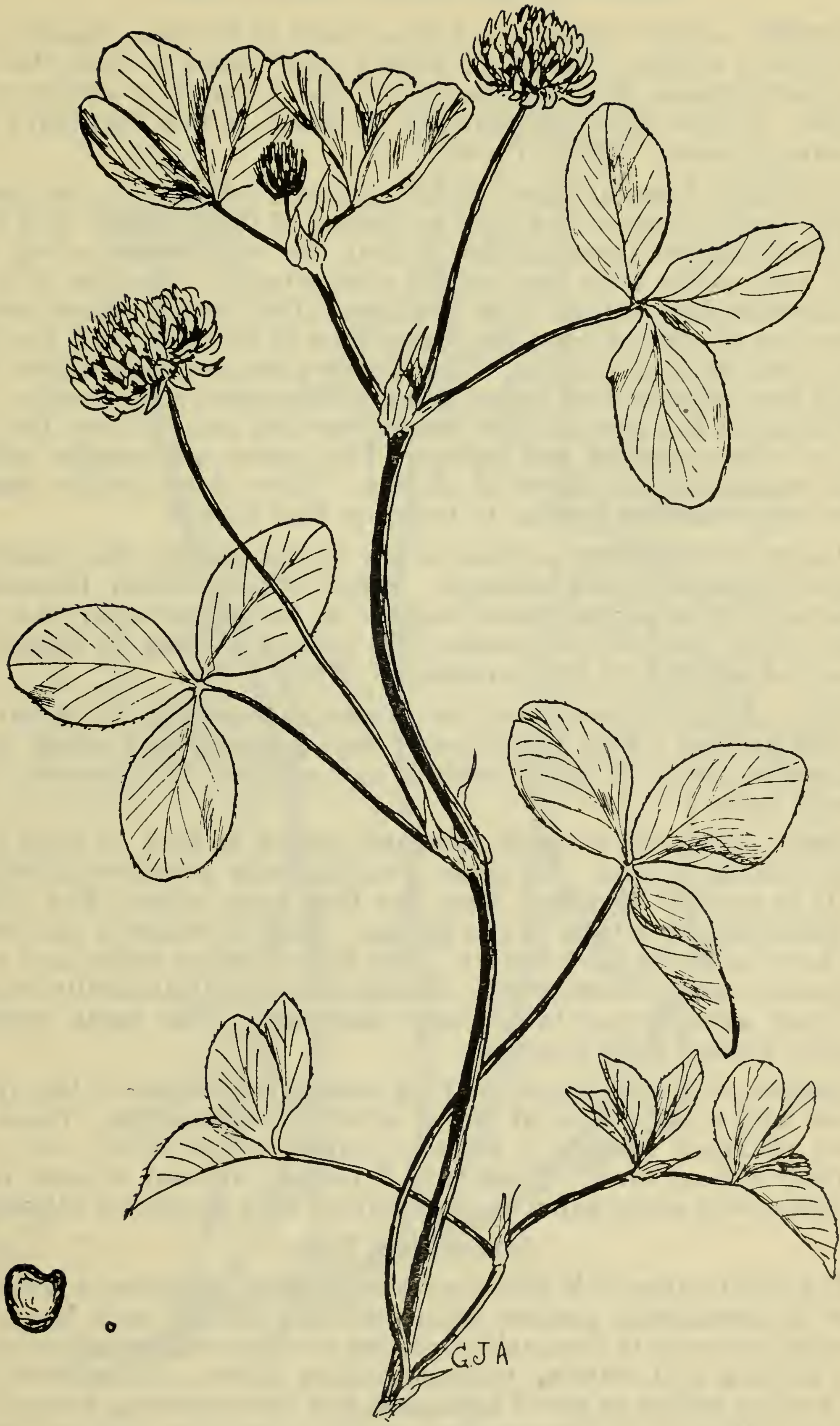
SOIL.—The most suitable soils for Alsike are moist clay and clay loams, although it gives good results on other types of soil where there is a good moisture supply. Alsike may be successfully grown on soils which are too wet for Red Clover.

SEED.—Alsike seed is about one-half the size of Red Clover and is heart shaped. It varies in color from a light green to almost a black. The seed is obtained from the first crop, which is often pastured for a time in the spring. Plants should be cut for seed when the heads have turned brown. The seed shells easily and,to prevent loss, the plants are often cut in the early morning when they are wet with dew. The legal weight per measured bushel is 60 pounds.

SEEDING.—Alsike may be successfully sown in the spring of the year with a nurse crop of barley or other cereal grain. Good results are also obtained when it is sown on winter wheat in the early spring on a fresh fall of snow. From 6 to 8 pounds of seed is sown per acre when this clover is not sown in combination with grasses or other clovers.

Agricultural Value.

In total value, Alsike is not the equal of Red Clover. It, however, surpasses this clover in being more perennial in character, in being a better pasture clover under most conditions, and in being a better hay plant on soils too wet to successfully grow Red Clover. It should be cut for hay when the plants are in full bloom or a small percentage of the heads have turned brown. It remains green and succulent longer than Common Red and is not injured as much when cut over-ripe for hay as is this clover. Alsike seldom produces more than one crop of hay in a season. The hay is cut and cured in the same manner as Red Clover. Alsike is a valuable clover in permanent pasture mixtures, especially on low land. It is one of the most valuable of honey plants. There is less variation in the individual plants of Alsike than is found in Common Red and there are no commercially recognized varieties or strains.



Alsike Clover
(*Trifolium hybridum*).

White Clover (*Trifolium repens*).

Other common name: Dutch Clover.

HISTORY.—This clover is a native plant of Europe, Russia in Asia, and northern Africa. Although widely distributed in both the United States and Canada, it is not thought to be a native of either of these countries. It was first cultivated in Holland, which fact gave rise to the common name "Dutch Clover."

BOTANICAL DESCRIPTION.—White Clover, which is a low growing, creeping plant, is one of the most perennial of the clovers. It is shallow rooted and differs from Alsike in that the solid stems creep on the ground and easily take root. This characteristic enables it to stand much mowing and rather close grazing. The heads, which are white in color, are produced from the lower part of the stem and are smaller in size than those of Alsike. The flowers are cross-fertilized chiefly through the influence of honey bees. The stems are smooth. These are so close to the ground that when they are cut for hay, the crop is nearly all flower-stalks and leaves. The leaves are smaller and more nearly rounded than those of Alsike. They have white markings, smaller but otherwise similar to those on Red Clover.

HABITS OF GROWTH.—When sown in the spring, the plants often produce blossoms in the autumn. When White Clover becomes well established, its creeping stems enable it to spread over the ground rapidly. The seed which reaches the ground retains its vitality for a long period and aids in the persistency of this clover.

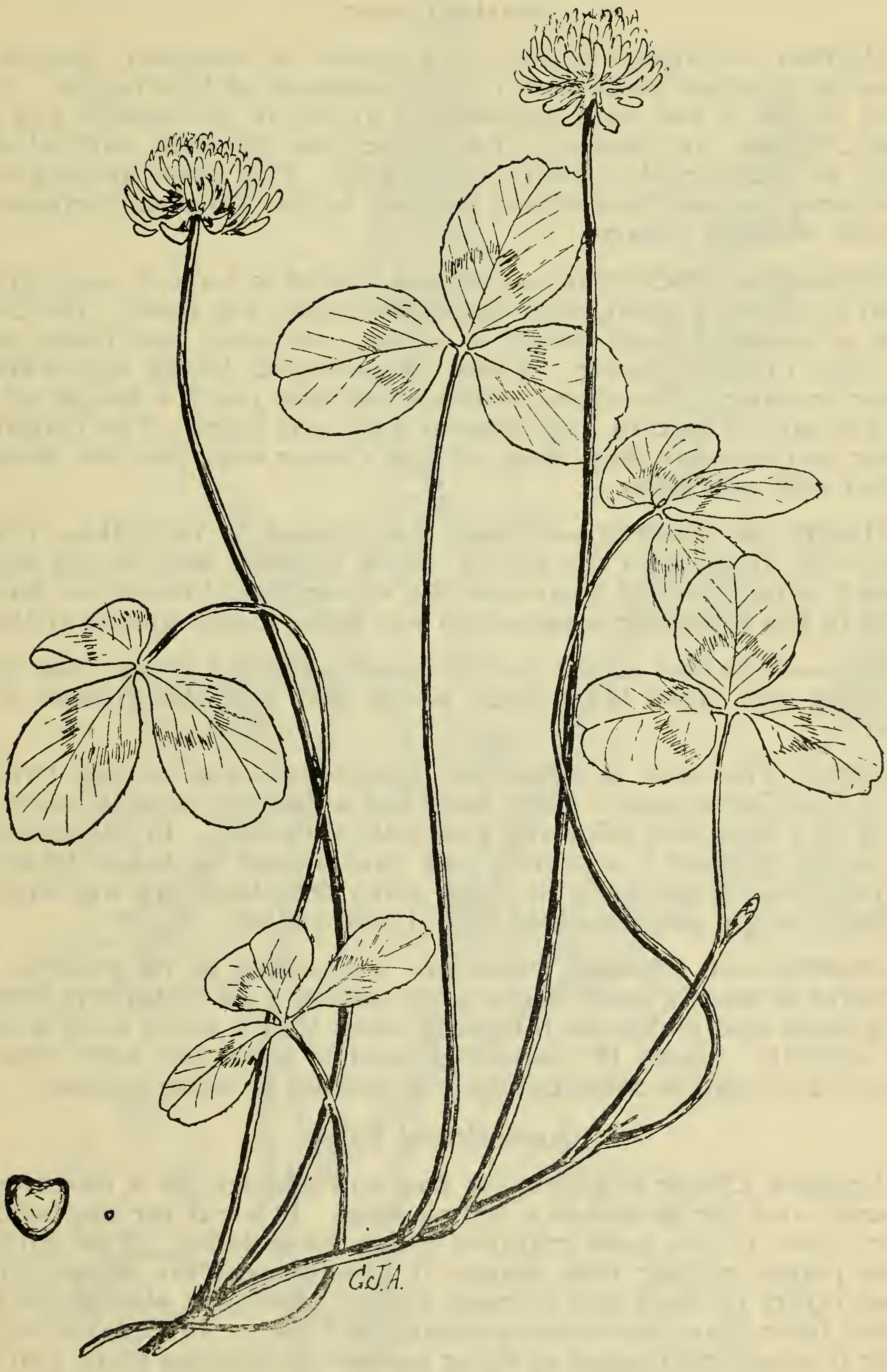
SOIL.—White Clover may be grown successfully on a variety of soils, but prefers a rich moist loam, well-drained, and which contains considerable lime. White Clover is not suitable for growing on poor or on wet soils.

SEED.—The seed is much the same shape as that of Alsike, but is slightly smaller in size. In color it varies from a yellow to an orange red. It is usually obtained from the first crop which, like Alsike, is often pastured for a time in the spring. Seed is ready to cut when the heads have turned a dark brown. The seed shatters easily and requires the greatest care in harvesting. White clover will naturally reproduce itself from seed if not too closely pastured. The legal weight per measured bushel is 60 pounds.

SEEDING.—White Clover may be successfully sown in the spring of the year with a nurse crop of barley or other cereal grain. Good results are also obtained when it is sown on winter wheat in the early spring on a fresh fall of snow. From 6 to 8 pounds of seed is sown per acre when this clover is not sown in combination with grasses or other clovers.

Agricultural Value.

The chief value of White Clover consists in its use as a lawn clover, its use in permanent pasture mixtures, and its use as a honey plant. As a lawn clover it is unequalled among clovers, withstanding considerable tramping and mowing without serious injury. Its perennial character, and its ability to stand tramping and close grazing make it one of the most valuable of clovers for use in permanent pasture mixtures. Here, its chief function is that of a bottom grass. With suitable soil and moisture requirements, it provides pasture much relished by all classes of stock and lasting from early spring until late summer. It produces a good quality of hay but an amount so small as to prohibit its general growth for this purpose.



White Clover
(*Trifolium repens*).

Crimson Clover (*Trifolium incarnatum*).

Other common names: Italian Clover, German Clover, French Clover, Scarlet Clover.

HISTORY.—Crimson Clover is a native of southern Europe and attains its greatest perfection in the countries of this region. In the United States, it has been successfully grown in the middle and south Atlantic States. In Ontario, it has so far been but little cultivated, due largely to unfavorable climatic conditions. The small amount of this clover grown is confined almost entirely to the Niagara Peninsula and to south western Ontario.

BOTANICAL DESCRIPTION.—Crimson Clover is a short, erect growing annual or winter annual, with strong branching tap roots. The flowers are in a spikelike head which is longer, narrower and more pointed than that of Red Clover. These cone-shaped heads are scarlet or crimson in color. The stems, which sometimes reach a height of three feet, are soft in texture and covered with soft hairs. The leaflets are shorter and broader than those of Red Clover and, like the stems, are covered with soft hairs.

HABITS OF GROWTH.—Where the climate is favorable, Crimson Clover will, if sown in the spring, often produce seed in the autumn. Where it is fall sown, if it survives the winter, it will produce a hay crop earlier in the following season than any other clover grown in Ontario.

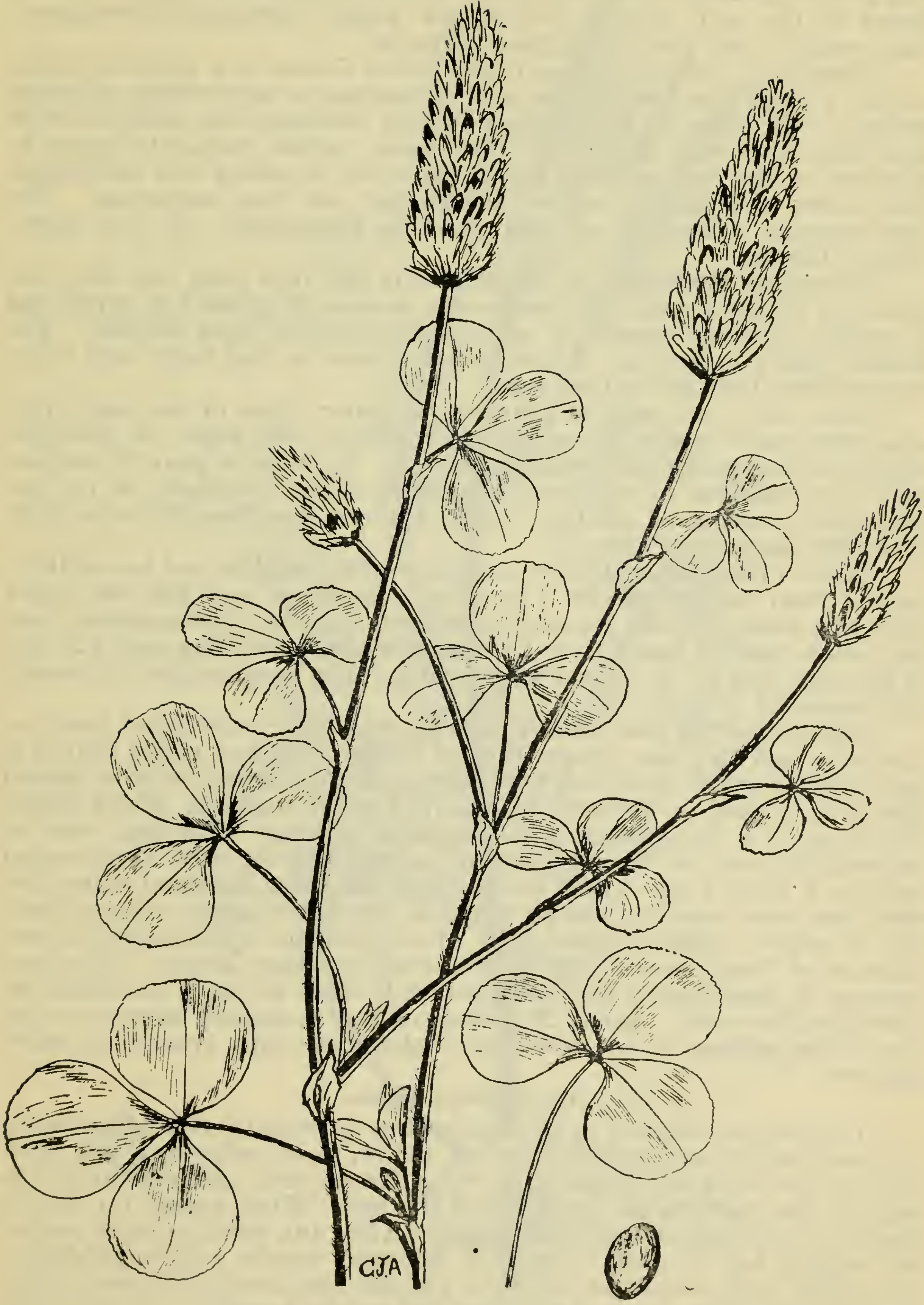
SOIL.—It is best suited to rich sandy soils and gives good returns on lighter soil types than those which best suit the growth of Red Clover.

SEED.—The seed is somewhat egg-shaped and almost twice the size of Red Clover seed. Good seed has a uniform pinkish color. Old seed is of a brownish color and generally shrunken. In harvesting, the seed easily shatters if over-ripe and care should be taken to see that the crop is cut in the early morning when the plants are wet with dew. The legal weight per measured bushel is 60 pounds.

SEEDING.—In climates which are well suited to its growth, Crimson clover is usually sown in the early autumn. In Ontario it is usually spring sown and makes such rapid growth that a nurse crop is seldom used with it. About 15 pounds of seed is sown per acre when this clover is not sown in combination with grasses or other clovers.

Agricultural Value.

Crimson Clover is grown for hay and pasture, as a cover crop in orchards, and for its use as a soiling crop. It is cut for hay when the lower leaves of the most matured plants have faded. The stiff hairs on the plants in their later stages of development are known to have caused injury to stock and Crimson Clover, therefore, should not be cut for hay later than the commencement of bloom. In Ontario, Crimson Clover is occasionally used as a hog pasture, sometimes alone and sometimes in combintion with other crops. As a cover crop, it possesses value because of its rapid growth and the early period in the spring at which it may be ploughed under. In numerous experiments conducted at the Ontario Agricultural College, Crimson Clover from autumn seeding has winter killed badly and from spring seeding has not equalled Common Red Clover when sown under similiar conditions for pasture or for hay.



Crimson Clover
(*Trifolium incarnatum*).

White Sweet Clover (*Melilotus alba*).

Other common names: Bokhara Clover, Melilot, Sweet Melilot, Melilotus

HISTORY.—This plant, which is a native of Europe and also of Asia, was first cultivated in western Asia. It was introduced into the United States by the early settlers and is now widely distributed throughout that country and also throughout Canada.

BOTANICAL DESCRIPTION.—White Sweet Clover is a biennial plant, having a deep tap root system and producing a very strong vigorous growth. The flowers, which grow in long racemes, are white in color and ripen seed very unevenly. The stems, which frequently grow to a height of five feet or even more, are much branched and spreading. The leaves resemble those of alfalfa but are less numerous. The characteristic fragrance of this plant is responsible for the name, "Sweet Clover."

HABITS OF GROWTH.—It grows slowly the first year and does not bloom or produce seed. In the second season, its growth is rapid and it reaches the hay condition several days earlier than alfalfa. The second year's growth of White Sweet Clover is less leafy and more stemmy than that of the first year.

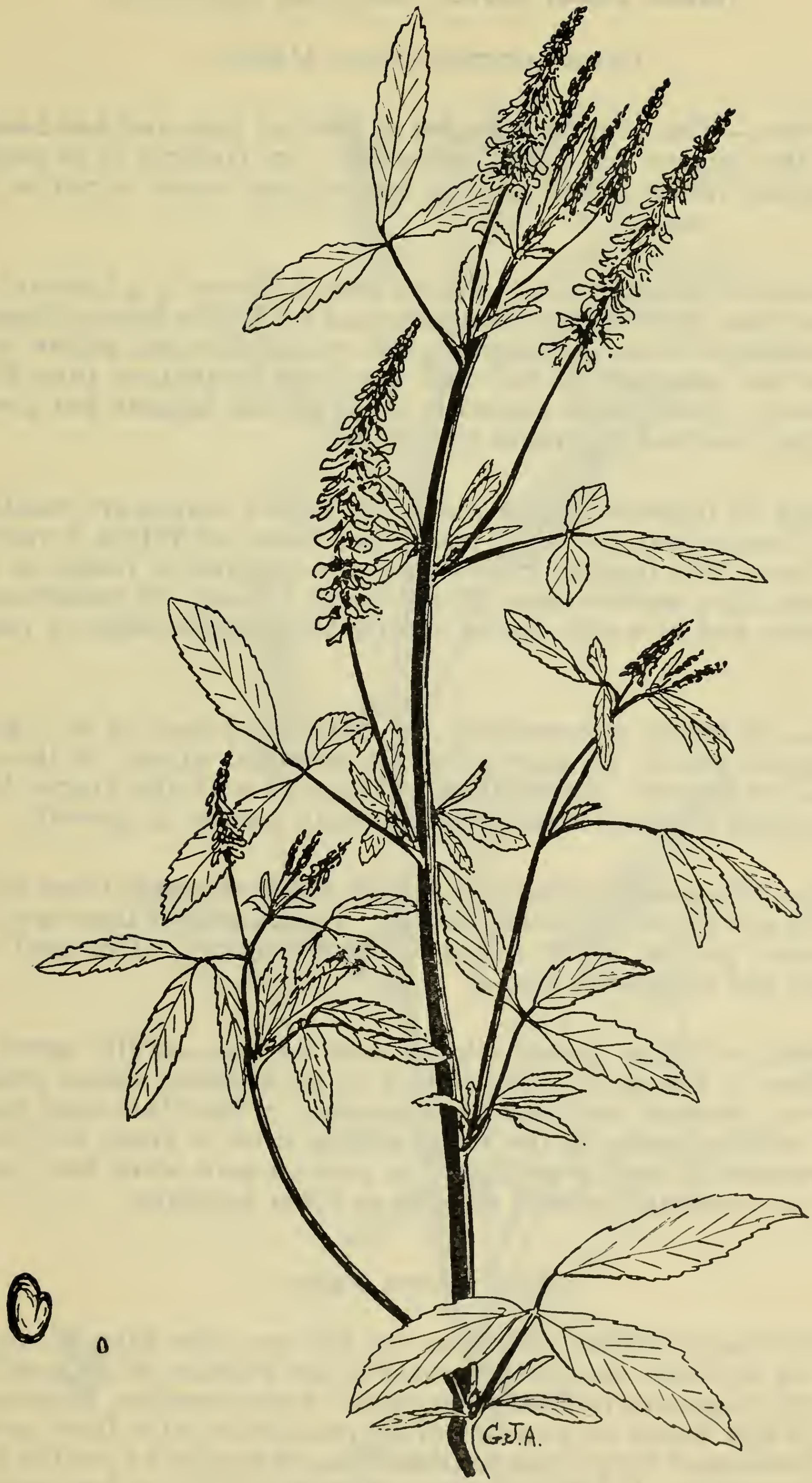
SOIL.—It is adapted to growing on many types of soil and gives especially good results on rather poor and on wet soils. A plentiful supply of lime in the soil favors its growth. In order to grow it successfully the presence of the proper bacteria is as necessary as for the successful growing of alfalfa. These bacteria are thought to be identical with those of alfalfa.

SEED.—The seed is shorter, usually slightly smaller and less kidney-shaped than that of alfalfa. In color it is yellow and has less lustre than this seed. White Sweet Clover seed may be distinguished from the yellow seed of Red Clover by a more distinct notching near the end of the seed and by its characteristic odor. The seed weighs 60 pounds per measured bushel.

SEEDING.—The ease with which Sweet Clover establishes itself on roadsides and in waste places has led to the mistaken belief that it is very easy to get a good catch of this crop. Experiments have shown that it is almost as difficult to secure a good stand of White Sweet Clover as it is to obtain a good stand of alfalfa. The seed may be successfully sown in the early spring, using barley or some other cereal grain as a nurse crop. Good results have also been obtained where the seed has been sown on winter wheat in the early spring after a fresh fall of snow. Sweet Clover seed often contains a considerable percentage of "hard seeds," the germination of which is poor. The percentage of germination of these seeds will often be much increased by scarifying the seed. About 20 pounds of seed is usually sown per acre when this legume is not sown in combination with grasses or other legumes.

Agricultural Value.

Its chief importance in agriculture lies in its suitability for growing on those soils where alfalfa does not thrive, in its value as a soil renovator, in its value for silage, in its value for pasture, and in its ability to improve the mechanical condition of the soil. When grown for hay, it should be cut just before blossoming. After the most suitable period for cutting hay is past, it quickly becomes woody and unpalatable. In cutting, care should be taken to cut the first crop sufficiently high above the ground so as not to injure the second growth. On poor soils and on poorly drained land, it produces more pasture than alfalfa. As a bee plant it possesses considerable value. The individual plants of White Sweet Clover differ much in height, in percentage of leaf to stem, and in coarseness of leaf and stem. Much improvement, therefore, is possible by selection.



White Sweet Clover
(*Melilotus alba*)

Yellow Sweet Clover (*Melilotus officinalis*).

Other common name: Melilot.

HISTORY.—This plant is a native of Central Asia and has been cultivated in this region for many centuries. In Ontario it is much less common than White Sweet and its agricultural value is not so widely known.

BOTANICAL DESCRIPTION.—Yellow Sweet Clover is a biennial with a smaller tap root system than that possessed by White Sweet Clover. The flowers resemble those of this plant but are smaller and yellow in color. The stems do not grow so tall and are finer in texture than those of White Sweet. The leaves resemble those of this legume but are somewhat deeper notched and more numerous.

HABITS OF GROWTH.—The plants of Yellow Sweet are smaller and are more decumbent the first year than those of White Sweet. The second season this legume grows very rapidly and is ready to cut for hay several days earlier than White Sweet Clover. It maintains itself on roadsides and in waste places chiefly through its habit of reseeding itself.

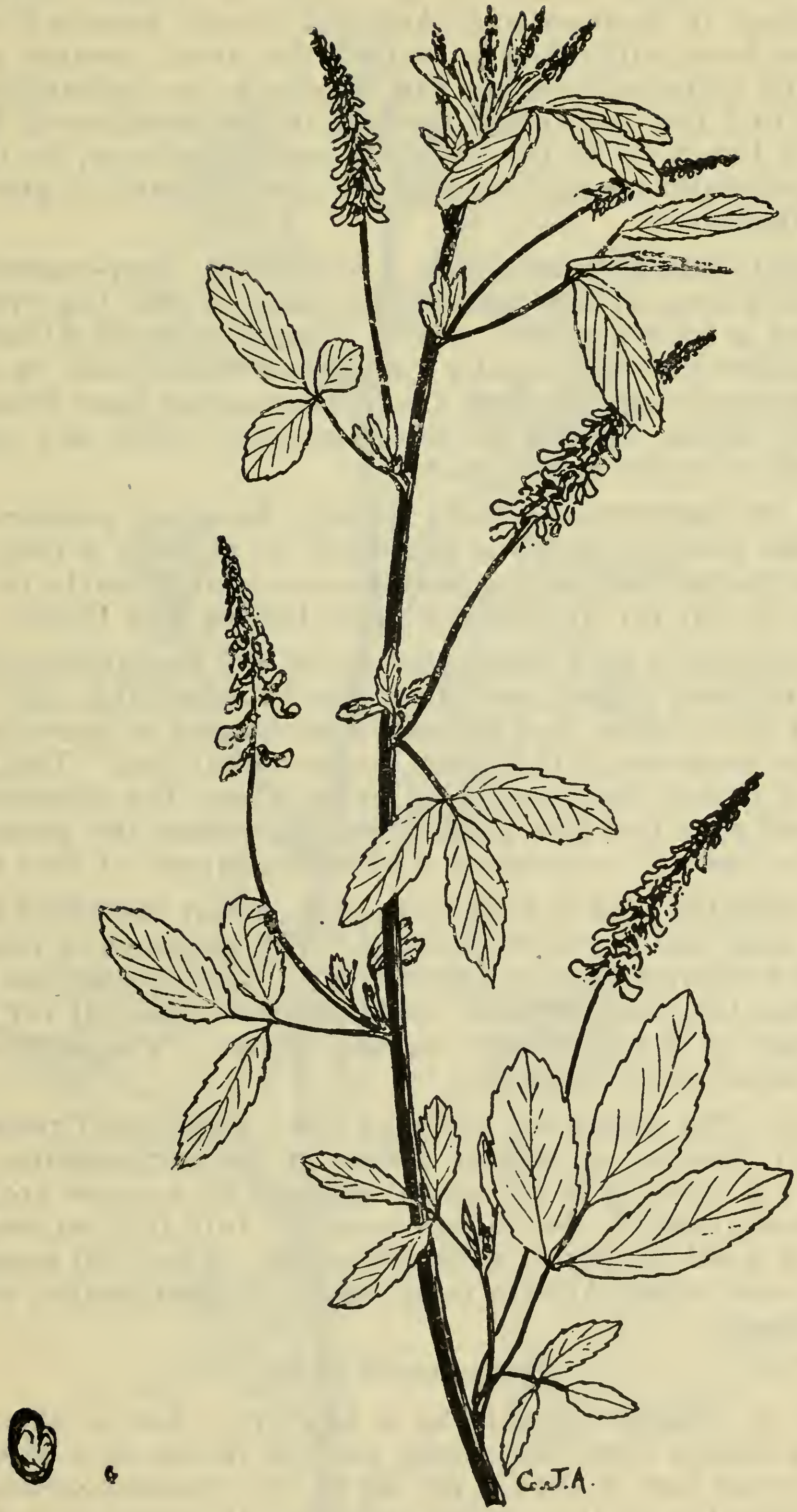
SOIL.—It grows successfully on different types of soil and will produce good results on poor soils. A plentiful supply of lime in the soil favors its growth. Inoculation of the seed with the proper bacteria in soils lacking in these organisms materially assists its growth.

SEED.—The seeds in shape and color much resemble those of White Sweet, but are slightly smaller in size. Occasionally, they are slightly mottled with purple which helps in identification. The seed weighs 60 pounds per measured bushel.

SEEDING.—Yellow Sweet Clover may be successfully sown in the early spring of the year, using barley or some other cereal grain as a nurse crop. Success has also been attained where this seed has been sown on winter wheat in the early spring after a fresh fall of snow. Twenty pounds of seed is sufficient to sow an acre when this legume is not sown in combination with grasses or other legumes.

Agricultural Value.

Yellow Sweet Clover produces less hay per acre than White Sweet Clover, and its value as a soil improver is less because of its smaller root system and its generally smaller growth. Some farmers, however, prefer it to White Sweet on account of its production of a finer quality of hay and because of its greater palatability. It should be cut for hay just before blossoming. If left later than this period, it soon becomes woody and fibrous, although this condition is reached less quickly than with White Sweet. It stands pasturing well and the pasture is relished by stock. Yellow Sweet Clover has considerable value as a bee plant and, in some sections, is sown especially for this purpose.



Yellow Sweet Clover
(*Melilotus officinalis*).

Alfalfa (*Medicago sativa*).

Other common name: Lucerne.

HISTORY.—Alfalfa is one of the oldest of fodder plants and has been cultivated in Europe and Asia for about twenty-five hundred years. It has been cultivated in Ontario for about seventy years. For years after its introduction into this province, its cultivation was confined largly to a few individual farmers in the counties of Haldimand, Welland and Lincoln. In the last few years, however, its merits have been more generally recognized and the area devoted to growing it has been largly increased.

BOTANICAL DESCRIPTION.—It is a long-lived, deep-rooted perennial legume with a typical tap root. The part of the tap root showing above ground is known as the crown. The flowers of Alfalfa are produced in clusters and are usually variegated or purplish in color. The stems are generally smooth and are less branched than those of Sweet Clover. The leaves consist of three leaflets which are narrow and sharply toothed in the upper part.

HABITS OF GROWTH.—Alfalfa usually does not produce sufficient growth in the year in which it is seeded to provide a crop of hay or pasture. In the second year, it commences growth early in the season and is ready to cut for hay several days before Red Clover.

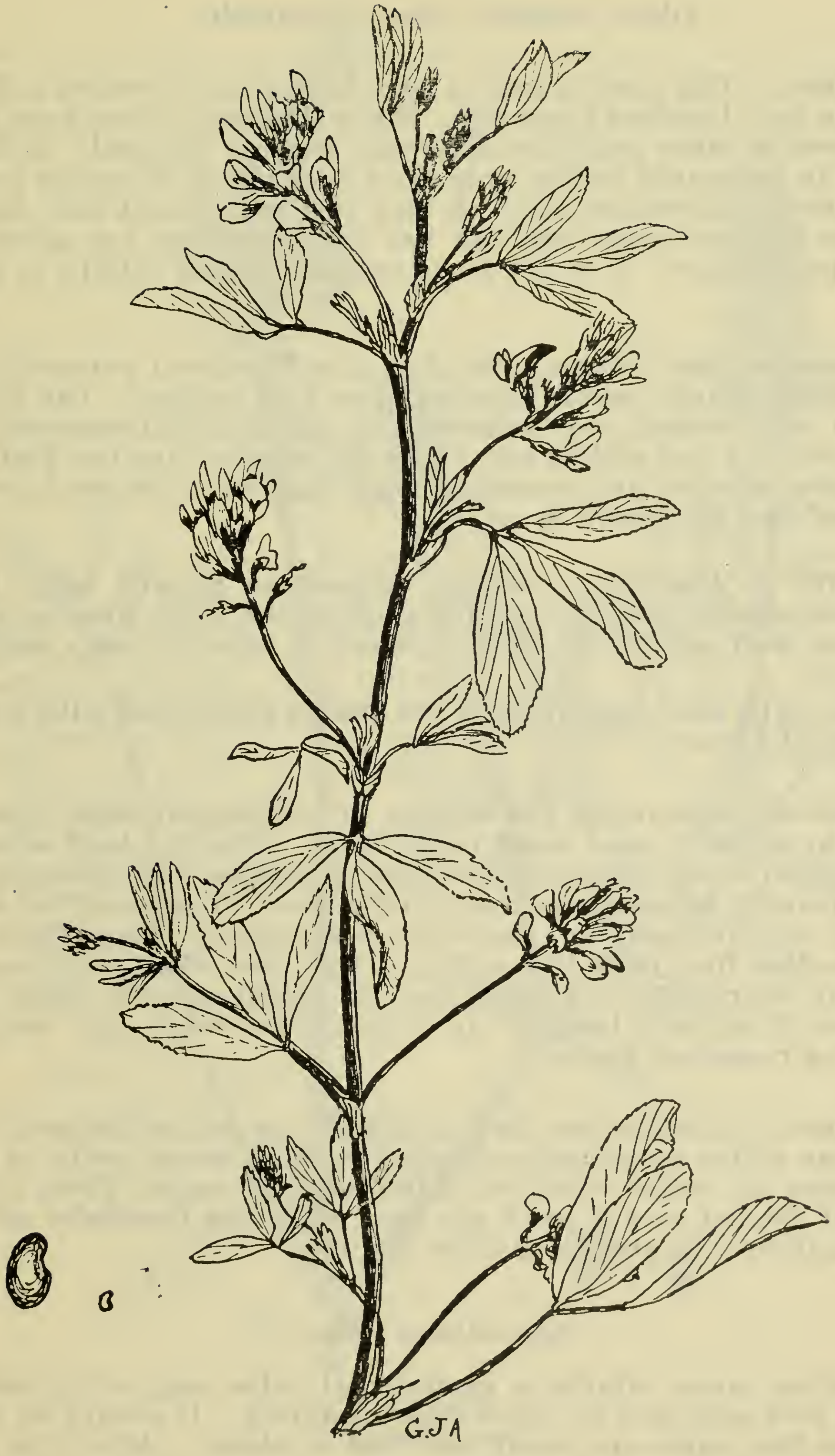
SOIL.—Alfalfa is very particular in its soil requirements, and failures to secure good stands are often due to unsuitable soil conditions. Definite soil types seem less necessary to success in growing this crop than does the presence of the other proper conditions. The best results are obtained where the sub-soil is open, where the drainage is good, where a good seed bed has been provided, where the proper bacteria are present in the soil, and where a plentiful supply of lime exists.

SEED.—Alfalfa seed is kidney-shaped, about one-third larger than Red Clover seed and is yellow in color. The presence of many deadish brown seeds indicates seed of low vitality. The largest seed yields are obtained from the first cutting. Alfalfa should be cut for seed when about one-half of the pods have turned brown. The legal weight per measured bushel is 60 pounds.

SEEDING.—The following methods have given good results in seeding Alfalfa:1. Sowing on winter wheat in the early spring on a fresh fall of snow; 2. Sowing in the early spring with a nurse crop of barley or other cereal grain; 3. Sowing alone about July 15th on well prepared land where a good supply of moisture exists. About 20 pounds of seed is sown per acre when Alfalfa is not sown in combination with grasses or other legumes.

Agricultural Value.

Alfalfa is chiefly valuable as a hay crop, but is also grown for pasture, as a soiling crop, for silage, and for its use as a green manure. When grown for hay it should be cut at the commencement of bloom or at the beginning of the second growth. It makes hay of excellent quality but the greatest care is necessary to preserve the leaves of the plants. In average seasons in most parts of Ontario, three cuttings of hay are produced. Alfalfa is a fair pasture plant but should never be pastured too closely, too early in the spring, or too late in the autumn. Many failures in growing Alfalfa have been due to the sowing of tender varieties or strains. The most suitable varieties of Alfalfa for growing in Ontario are Ontario Variegated and Grimm.



ALFALFA
(*Medicago sativa*).

Sainfoin (*Onobrychis sativa*).

Other common name: Esparsette.

History.—This plant is said to have been first cultivated in France more than four hundred years ago. Since that date it has been extensively grown in other countries of Europe, notably England. In Europe it added an important fodder crop asset because of its ability to grow on dry barren calcarious soils. It was first introduced into America about one hundred years ago, but has never attained any great agricultural prominence. It is not to be compared with alfalfa in fodder value.

Botanical Description.—Sainfoin is a long-lived perennial plant with a deep, woody, much branched tap root system. The flowers, which are rose-colored, are contained in a spikelike inflorescence. The stems grow erect and seldom reach a height greater than two feet. The leaves are compound and consist of many leaflets. The seed pods are one-seeded and are brown in color.

Habits of Growth.—Sainfoin commences growth early in the spring and reaches the hay condition about the same time as alfalfa. When once well established on suitable soil, it lasts for many years.

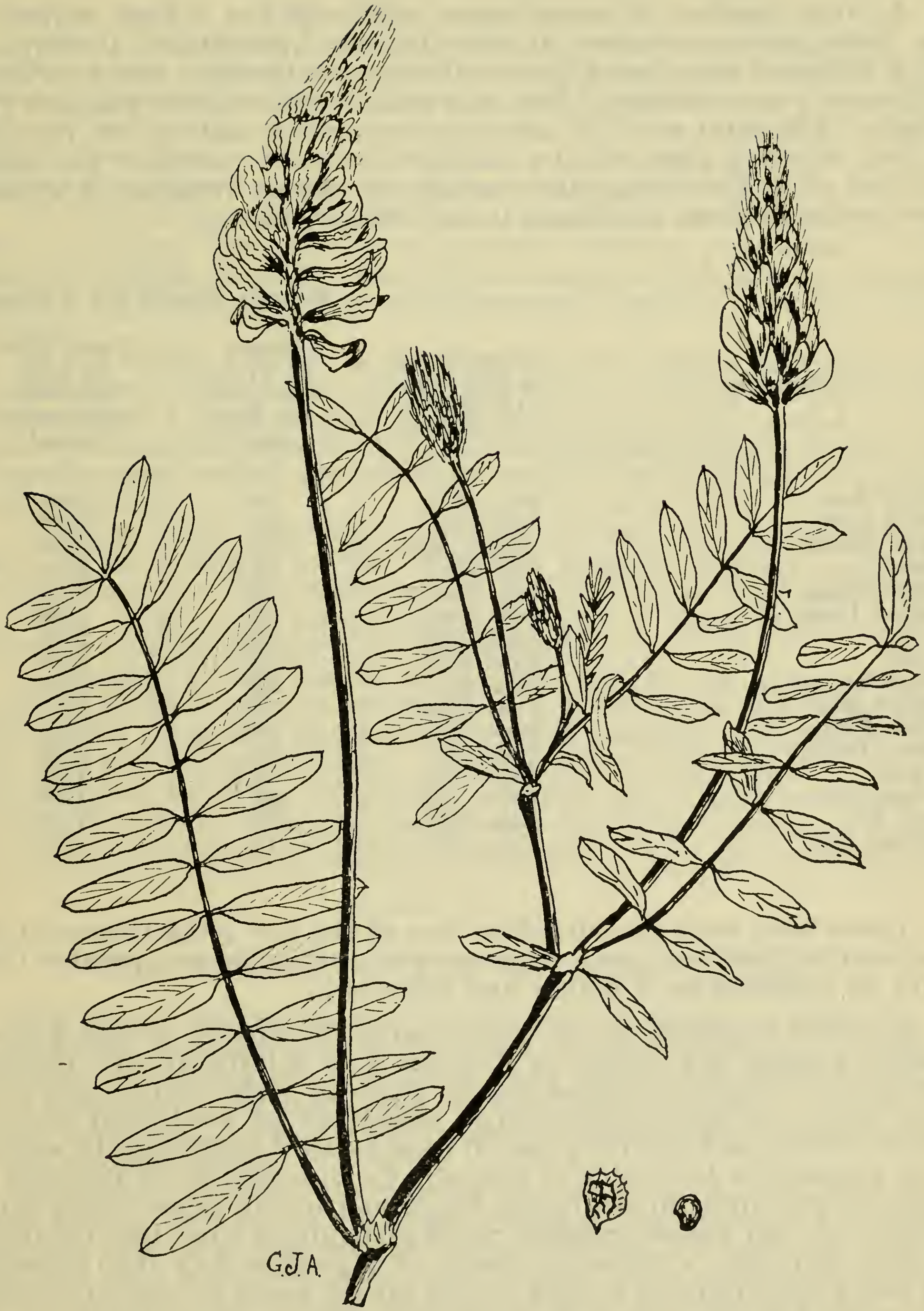
Soil.—The most suitable soils are friable clay loams with a plentiful supply of lime.

Seed.—On account of low vitality of commercial seed, it is often difficult to obtain a good stand of Sainfoin. It is sold both as shelled and unshelled seed. The unshelled seed is cheaper and occurs in much greater quantity in commerce than shelled seed. The unshelled seed or seed-pods are flattened and somewhat bean-shaped, the surface being covered with a fine, mesh-like netting. The outer edge of the seed pod has strong sharp teeth. Shelled seed is kidney-shaped, about three-sixteenths of an inch long, of an olive brown color, and weighs 60 pounds per measured bushel.

Seeding.—Sainfoin may be successfully seeded in the early spring of the year with a nurse crop of barley or other cereal grain, or in the early spring on winter wheat on a fresh fall of snow. From 50 to 60 pounds of shelled seed is sown per acre when this legume is not sown in combination with grasses or other legumes.

Agricultural Value.

Sainfoin excels alfalfa in agricultural value only in its ability to grow on poor soils and to stand close pasturing. It should be cut for hay when the plants are about one-third in bloom. After this period it rapidly becomes woody and loses much of its feeding value. In favorable seasons, it will produce two crops in the one year. It is ready to pasture fully as early in the spring as alfalfa and will stand pasturing by sheep better than this plant. It is considered a valuable bee plant.



SAINFOIN
(*Onobrychis sativa*).

GRASSES GROWN FOR HAY PRODUCTION

A large number of experiments continued for a long period of time, have been conducted at the Ontario Agricultural College, in testing different varieties of grasses for hay production. Some varieties produce only one cutting of hay in a season while others produce two cuttings. The total yield of hay indicated in the table below includes the hay obtained from all the cuttings for each variety. The table following gives the comparative results of sixteen varieties of grasses grown under uniform conditions in each of six years:-

Varieties	Date when in Full Head (Average) 4 Years)	Average Results for 6 years	
		Height of Crop when cut for Hay (ins.)	Total Yield of Hay per Acre per annum (tons)
Western Rye	July 13th	30	3.98
Virginia Lyme	July 21st	31	3.65
Fringed Brome	August 2nd	33	3.39
Timothy	July 5th	34	2.84
Bearded Wheat	July 21st	32	2.83
Canadian Lyme	July 22nd	28	2.76
Tall Oat	June 21st	42	2.75
Orchard	June 23rd	33	2.16
Awnless Brome	July 2nd	22	1.82
Canadian Blue	June 22nd	18	1.71
Meadow Fescue	June 26th	30	1.53
Meadow Foxtail	June 6th	30	1.42
Red Top	July 13th	20	1.23
Kentucky Blue	June 17th	23	1.20
Yellow Oat	June 27th	27	1.19
Perennial Rye	June 18th	19	.76

These tests were conducted on one of the low lying ranges in the experimental field and as a consequence, the yields are greater than would be expected on a higher and drier soil.

It will be noticed in the above table that many of the highest yielding grasses are native of Canada and chiefly of the Western Provinces. Timothy occupies fourth place in yield of hay per acre. When yield per acre, palatability, cheapness of seed, and ease of seeding, curing and handling are all considered it is difficult to surpass in the grasses the hay value of Timothy for growing in the Province of Ontario. The first three grasses mentioned in the table, while large yielders, are all coarse grasses, more difficult to sow, less palatable for hay, and with a lower per cent. of digestible hay than timothy. Tall Oat grass produces a yield of hay almost equal to that of timothy but the seed is more expensive and very much more difficult to sow than that of this grass. Awnless Brome grass which has given good results in parts of Central Europe and also in Western Canada, does not seem to be well suited for hay production in Ontario. Meadow Foxtail, the earliest maturing of the sixteen grasses, gives better results for pasture than for hay. Perennial Rye which is one of the common hay grasses of Europe, has given comparatively low yields of hay in the experiments at Guelph.

VARIETIES AND STRAINS OF TIMOTHY

A large amount of investigational work has been conducted at Guelph in testing different varieties and strains of timothy. This work started at Guelph in 1908. The results of these investigations and the experience of farmers throughout the Province have indicated that timothy is an excellent grass for hay production. As a pasture grass, however, farmers find that it gives poor results in a hot dry summer at a time when pasture is in most demand. The experimental work at Guelph, therefore has been conducted with the idea of improving not only the hay value but also the pasture value of timothy.

In the average of an experiment conducted for a period of four years in testing three strains of timothy for hay production, it was found that Early Timothy produced an average of 1.50 tons; Common Timothy, 1.35 tons; and Stewart's Mammoth Timothy, 1.34 tons of hay per acre.

In the spring of 1915, seed of ten selected strains of timothy was obtained from Cornell University, Ithaca, N. Y. These selected strains resulted from a large amount of investigational work carried on over a period of years at Cornell. The highest yielding strain in the average of the five year period, produced .62 tons of hay more than the lowest yielding strain.

A more recent experiment started in 1923 and continued for a period of four years, showed that the greatest average yield was obtained from two early maturing strains, F. C. I. No. 9335 and F. C. I. No. 9647. F. C. I. are letters used by the U. S. Department of Agriculture to indicate Forage Crop Introduction.

A number of the strains of timothy still in the plant breeding ranges at Guelph and not yet brought into the field plot tests, show considerable promise. Minnesota No. 88 is a strain which shows both good hay and pasture qualities. Minnesota No. 89, although later in maturing than the other Minnesota selection just mentioned, seems to be a type adaptable to the production of both hay and pasture. F. C. I. No. 11901, an early maturing strain, possesses good hay characteristics.

CLOVERS GROWN FOR HAY PRODUCTION

Clovers are among the most valuable crops grown on the farms of the Province. Not only do they furnish a large percentage of the nitrogen supply in stock feeds, but also a large part of the nitrogen supply in soil fertilization. These crops improve the mechanical condition of the soil and play a large part in making the soil fertility available for the use of other plants.

The three common varieties of clovers, namely, Common Red, Mammoth Red, and Alsike have been grown at the Ontario Agricultural College at various periods during the last fifty years. In an experiment conducted for a period of seven years, it was found that the Mammoth Red yielded 2.94 tons; Alsike clover, 2.82 tons; and Common Red, 2.79 tons of hay per acre. In each case only one crop of hay was taken per season from Mammoth Red and Alsike clovers while in most years during which the experiment was conducted two cuttings were obtained from Common Red. Several promising strains of each of these clovers are under test in the experimental plots at Guelph at the present time. One of the chief results that it is hoped will be obtained from this plant breeding work is the production of a strain of Red Clover which will reach the hay condition at almost the same time as timothy. Commercial Red Clover grown in Ontario to-day reaches this condition several days before timothy is ready to cut for hay.

In the following table will be found the average of three years' results in testing the three clovers above mentioned for hay production, along with White or Dutch clover, Alfalfa, and Yellow Trefoil:

Varieties	1900 (tons)	1907 (tons)	1916 (tons)	Average 3 Years (tons)
Alfalfa	4.60	4.00	4.15	4.25
Mammoth Red	3.20	2.95	4.88	3.68
Alsike	3.00	1.90	4.80	3.23
Common Red	3.10	2.25	4.25	3.20
Yellow Trefoil	1.40	1.63	3.95	2.33
White or Dutch	1.80	1.06	2.70	1.85

Alfalfa usually gives its maximum yield per acre in its third year's growth.. The results in the above table, therefore, do not do the alfalfa crop full justice as the yields from the other clovers were taken when these were at their best; the year after seeding.

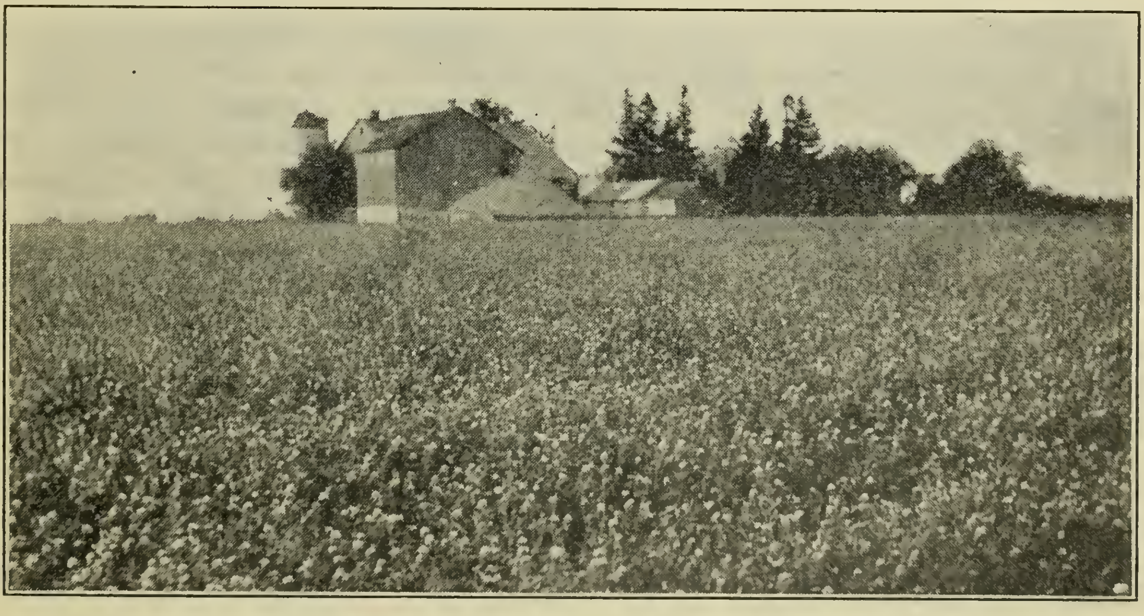
ALFALFA GROWN FOR HAY PRODUCTION.

In each of the past thirty-one years, experiments have been conducted at the Ontario Agricultural College in growing alfalfa for hay production. The results for 1899 and for 1905 are rather unsatisfactory, because of insufficient detail and are not included in the summary table below. The results in the table are the average of a number of seedings of alfalfa. Seeding in each case took place in the spring of the year with a nurse crop of grain, usually barley. The nurse crop was sown at the rate of one bushel per acre and the alfalfa seed at the rate of eighteen to twenty pounds per acre.

Three cuttings per annum of alfalfa hay were obtained in each of twenty-seven years. In 1896, four cuttings were produced in the single season, while in 1907, 1924, 1927 and 1928 only two cuttings were harvested. The total alfalfa hay yield was over six tons in each of three years, between five and six tons in each of ten years, between four and five tons in each of ten years, and less than four tons in each of eight years. The average total quantity of hay produced from the first cutting was almost half a ton more than the total amount of hay produced by the second and third cuttings. The average yield of the second cutting of hay was almost twice that obtained from the third cutting. The average total yield of green crop for the thirty-one year period was almost 18 tons per acre and of dried hay over 4½ tons per acre. The first crop of hay in the average of the thirty-one year period was cut on June 24th, the second crop on August 1st, and the third crop in the average of twenty-seven years, on September 18th.

The next table gives the yields per acre of the different cuttings of green alfalfa and of cured hay for each of thirty-one years, as well as the total yield of both green crop and hay each year and for the average of the thirty-one year period:-

	GREEN CROP (tons)					HAY (tons)				
Year	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	Total	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	Total
1896	9.96	6.47	4.06	2.06	22.55	3.08	1.91	1.29	.65	6.93
1897	12.04	5.61	4.42	....	22.07	3.59	1.56	1.23	......	6.38
1898	9.71	5.85	2.64	......	18.20	2.30	1.75	.63	......	4.68
1900	11.93	6.00	1.60	......	19.53	2.33	1.47	.80	......	4.60
1901	9.70	2.20	7.49	......	19.39	2.03	1.00	1.50	......	4.53
1902	13.35	8.69	2.96	......	25.00	2.50	2.02	.54	......	5.06
1903	13.10	8.53	2.75	......	24.38	2.50	2.09	.67	......	5.25
1904	12.45	9.35	4.00	......	25.80	3.40	2.50	1.08	......	6.98
1906	9.78	6.60	4.85	......	21.23	2.55	1.13	.58	......	4.26
1907	14.55	3.95	......	......	18.50	2.95	1.05	......	......	4.00
1908	9.70	6.75	3.73	......	20.18	2.50	1.15	.75	......	4.40
1909	8.68	4.56	.84	......	14.08	2.52	1.40	.14	......	4.06
1910	15.08	3.88	4.76	......	23.72	2.94	.80	1.32	......	5.06
1911	8.00	1.80	1.36	......	11.16	1.76	.34	.30	......	2.40
1912	9.48	4.68	4.72	......	18.88	2.08	.99	.56	......	3.63
1913	9.00	2.96	2.33	......	14.29	2.66	.88	.68	......	4.22
1914	7.64	1.61	4.28	......	13.53	2.32	.54	1.02	......	3.88
1915	10.63	6.06	6.92	......	23.61	3.07	1.31	1.53	......	5.91
1916	13.29	6.86	2.40	......	22.55	3.10	1.60	.83	......	5.53
1917	12.04	5.54	2.60	......	20.18	2.40	1.50	.90	......	4.80
1918	2.38	1.98	2.00	......	6.36	.64	.60	.66	......	1.90
1919	5.20	1.84	2.12	......	9.16	1.60	.64	.92	......	3.16
1920	4.84	5.28	2.74	......	12.86	1.52	1.42	.92	......	3.86
1921	10.84	4.73	4.74	......	20.31	3.20	1.40	1.22	......	5.82
1922	11.13	5.65	3.03	......	19.81	2.74	1.44	.95	......	5.13
1923	10.92	5.61	3.21	......	19.74	2.73	1.64	.91	......	5.28
1924	11.74	7.00	......	......	18.74	3.42	1.81	......	......	5.23
1925	10.03	3.14	3.62	......	16.79	3.02	.88	1.24	......	5.14
1926	4.59	1.73	1.51	......	7.83	1.37	.54	.49	......	2.40
1927	5.35	4.30	......	......	9.65	2.04	1.43	......	......	3.47
1928	8.59	6.05	......	......	14.64	2.56	1.84	......	......	4.40
Average 31 Years	9.86	5.01	2.96	.06	17.89	2.50	1.31	.76	.02	4.59



An excellent field of red clover which is almost ready for the mower.

Plant breeding work with alfalfa started at the Ontario Agricultural College in 1908. Seed of hardy varieties were imported at this time from countries where the climate was sufficiently severe to insure natural selection of hardy types. This seed was planted in nurseries and the best plants were caged and self-fertilized. Similiar work was done with the succeeding generations until 1926, when an acre nursery was planted from the seed of sixteen superior plants which had in their pedigree, three to five generations of self-fertilized selected plants. These sixteen strains are being studied at present for winter hardiness, forage type, and seed production. One of these strains appears to be distinctly outstanding in winter hardiness but further selection work will be desirable in order to obtain greater uniformity of type.

The method described in the above paragraph in the improvement of alfalfa is a method also used in the improvement of other forage crops at the Ontario Agricultural College.

No hay crop grown in Ontario gives as large yields of hay per acre as alfalfa; no other hay crop has as wide adaptability for feeding to different classes of stock as alfalfa; and no other hay crop has as high a feeding value or produces as large an amount of total food nutrients as alfalfa. It stands in the forefront of all the crops grown for hay production over a wide range of the American Continent.

MIXTURES OF ALFALFA, CLOVERS, AND GRASSES FOR HAY PRODUCTION

Six separate yearly tests have been conducted in growing, under uniform conditions, sixteen mixtures of grasses and clovers for hay production. Alfalfa, Common Red clover, Mammoth Red clover, and Alsike clover were used in combination with Timothy, Orchard grass, Tall Oat grass, and Tall Fescue grass. Each mixture consisted of a grass and a legume. The mixtures produced either two or three cuttings each season, the third cutting resulting from the mixture containing alfalfa. Seed mixtures were sown with a grain crop in every case. No crop was obtained in the same year in which the seed was sown. The cuttings were made, in every instance, from the second and the third years after seeding took place. Two or three separate weighings were made of the hay from each plot in order to make accurate determinations. The following table gives the average annual yield of green crop and of hay per acre per annum for the six separate tests of each of sixteen mixtures:-

Mixtures	Green Crop (tons)	Hay (tons)
Alfalfa and Tall Oat	18.17	5.20
Alfalfa and Orchard	18.56	4.85
Alfalfa and Timothy	17.24	4.64
Alfalfa and Tall Fescue	18.81	4.57
Mammoth Red and Tall Oat	12.90	4.08
Common Red and Tall Oat	12.18	4.02
Mammoth Red and Timothy	13.41	3.91
Mammoth Red and Tall Fescue	13.77	3.86
Mammoth Red and Orchard	12.57	3.75
Common Red and Tall Fescue	12.88	3.47
Common Red and Orchard	11.17	3.46
Alsike and Tall Oat	10.22	3.41
Common Red and Timothy	12.02	3.40
Alsike and Orchard	9.52	2.98
Alsike and Tall Fescue	9.70	2.86
Alsike and Timothy	9.02	2.64

It is at once noticeable that alfalfa plays a dominant part in the yield of mixtures when grown for hay production. The four mixtures producing the highest yields of hay per acre all contained alfalfa. Three out of the four mixtures which contained alsike are at the bottom of the list in yield of hay per acre. Tall Oat grass which is the most prominent of grasses in the table above, is widely grown in Europe but only to a limited extent in Ontario. Both the mixtures, alfalfa and Tall Oat, and alfalfa and Orchard Grass, make excellent pasture combinations, provided they are not too closely pastured especially in late autumn.

A hay mixture made up of Tall Oat Grass, Meadow Fescue Grass and Alfalfa, which yielded more than three tons of hay per acre from first cutting.

MILLET FOR HAY

The best varieties of millet make good annual hay crops and on the average have a higher feeding value than most of the grass varieties. Among the best yielding varieties tested at Guelph are the Japanese Barnyard, Japanese Panicle, Siberian O. A. C. No. 92, and Hungarian millet. Experiments at the Ontario Agricultural College indicate that when earliness of maturity, yield and quality of hay per acre and yield of seed are all considered that the Hungarian and Siberian O. A. C. No. 92 are two of the best varieties for growing in Ontario. The Japanese Panicle is quite late in maturing and the Japanese Barnyard is a rather coarse stemmed and coarse leaved millet. Millet allows weeds to grow more rapidly than does buckwheat and is, therefore, not so useful as a smother crop. This crop should always be sown on a well prepared seed-bed as the season of growing millet is usually a favorable one for the growth of weeds. In a Dates of Seeding experiment conducted at Guelph using Hungarian and Siberian O. A. C. No. 92 varieties it was found that these varieties produced the largest yield per acre when sown on the date of June 1st. There was only a slight decrease in yield, however, when these two varieties were sown as late as June 10th. From one-half to three-quarters of a bushel of seed is enough to sow an acre of the two varieties mentioned. Best hay of these varieties is produced when the millet is cut when the plants are fully in head. The hay is more difficult to cure than timothy and should be exposed for as short a time as possible to hot sunshine and wet weather.

MILLETS GROWN IN MIXTURES FOR HAY PRODUCTION

Experiments have been conducted at the Ontario Agricultural College in sowing millets in mixtures along with soy beans, Early Amber Sugar sorghum, white sweet clover, and Billion Dollar grass. In an experiment in which three varieties of millets were sown each at the rate of 24 pounds per acre, with sweet clover at the rate of 15 pounds per acre, it was found, in the average of three years' results, that the mixture of Hungarian millet and Biennial White sweet clover, which, on analysis after harvesting, was made up of approximately fifty per cent. of each crop, was the most satisfactory to grow for annual hay production. The total yield of hay per acre in the average of the three years was very close to that of Hungarian millet grown alone for hay production.

A MIXTURE OF PEAS AND OATS FOR HAY.

Experiments conducted over a period of several years at the Ontario Agricultural College have shown that mixtures produce larger yields of annual hay than crops grown singly.

Two bushels of oats and one bushel of peas, making a total seeding of three bushels per acre has produced the best results. The varieties best suited for sowing in this combination are O. A. C. No. 144, O. A. C. No. 72, or Banner oats and O. A. C. No. 181, Golden Vine, or Prussian Blue peas. This mixture is ready to sow as soon as a good seed-bed can be prepared in the spring and is ready to cut for hay when the pea pods are about half grown. The hay of this mixture is cured in the same manner as the common hay mixture, timothy and red clover. In addition to being a good annual hay mixture it also makes a good soiling crop.

SOY BEANS FOR HAY.

The soy bean crop has been grown in Ontario for almost forty years but so far has not attained any very great prominence. A total of one hundred and six varieties of soy beans have been tested at Guelph for both forage and seed production. The O. A. C. No. 211, a variety which was developed by plant selection from the Habaro, which variety was imported direct from Japan by the Ontario Agricultural College, is the outstanding variety which has been tested at Guelph. It is the only variety eligible for registration in Canada. The O. A. C. No. 211 soy bean is early in maturing, produces seed of medium size which is oval and somewhat flattened in shape and yellow in color. The seed of this variety matured at the Ontario Agricultural College in each of the last seven years.

Soy beans are taller growing and have a wider spreading growth than common beans. Both the leaves and stems of the soy bean plant are quite hairy. When suitable varieties are sown the crop is less subject to injury by frost than the common bean. Good crops of soy beans have been grown at Guelph when planting took place as early as the last week in April or the first week in May. When grown for hay production the O. A. C. No. 211 variety should be sown at the rate of about one and one-half bushels per acre. No other forage crop grown in Ontario has as high a nitrogen content as the soy bean.

Experiments conducted at the Ontario Agricultural College indicate that this crop is an excellent annual hay crop. For this purpose it should be cut when the pods are about one-half grown. The crop is cured and handled in the same way as an ordinary hay crop. Soy beans may be profitably used for soiling purposes, as a green manuring crop and for silage. Investigations are now under way at the Ontario Agricultural College to ascertain the feeding value of the grain of this crop for different classes of livestock.

O. A. C. No. 211 Soybeans, a crop very rich in protein and used for annual hay, silage and green manure.

GRASSES, CLOVERS, AND ALFALFA SOWN IN THE AUTUMN AND IN THE SPRING WITH AND WITHOUT NURSE CROPS.

On three different occasions an experiment was conducted in the experimental grounds in sowing three varieties of grasses, two varieties of clover, and one variety of alfalfa in the autumn with winter wheat and without winter wheat, and in the spring with oats and without oats. The cropping took place in 1898, 1901 and in 1906. The fact that this experiment was conducted in three separate periods covering different seasons adds value to the results obtained. The same quantities of seed were used in each of the three seedings. The crops when they had reached the proper stage of maturity, were cut and weighed in the green condition. The hay was carefully cured, three dry weights being taken in each case. The third dry weight constituted the hay crop at which time the crop in the field had ceased to lose weight in the process of curing. The results in the table below represent the average yield of hay in tons per acre for each crop sown under the different conditions of the experiment. The figures in each case represent the average of three distinct tests.

Crops	Autumn Sowing		Spring Sowing	
	Winter Wheat as Nurse Crop (tons)	No Nurse Crop (tons)	Oats as Nurse Crop (tons)	No Nurse Crop (tons)
Orchard Grass	3.26	3.60	4.05	3.13
Meadow Fescue	2.44	2.36	3.52	2.94
Timothy	3.26	3.18	3.68	3.63
Common Red Clover	2.86	1.16	3.32	3.35
Alsike Clover	2.51	.90	2.57	2.39
Alfalfa or Lucerne	3.56	1.24	4.11	3.97
Average 3 Grasses	2.99	3.05	3.75	3.24
Average 3 Legumes	2.98	1.10	3.35	3.24

It will be seen that the figures given in the tabulated results represent the yields per acre for only one year which was the second summer after the seeding took place. In the first experiment the Orchard grass, the Meadow Fescue and the Timothy, which were sown in the autumn without a grain crop, produced hay in the next summer as follows:- Orchard Grass, 3 tons per acre; Meadow Fescue, 4.6 tons per acre; and Timothy, 4.6 tons per acre. In the second experiment these same three grasses which were sown in the autumn without winter wheat also produced hay the following year, the yields being as follows:- Orchard grass, 1 ton per acre; Meadow Fescue, 1.1 tons per acre; and Timothy, 2.1 tons per acre. Each of the grasses and the clovers sown in the first experiment without grain crop in the spring of the year produced the following yields of hay per acre in the first summer after the seed was sown:- Orchard grass, 2.2 tons; Meadow Fescue, 3.2 tons; Timothy, 1.7 tons; Common red clover, 1.9 tons; Alsike clover, 2.1 tons; and Alfalfa, 1.5 tons. These were the only crops which produced sufficient quantity to cut and weigh in the first summer after sowing.

It will be observed from the figures given in the table here presented that the amount of hay produced from sowing the clover and the alfalfa in the autumn of the year without any grain crop was very small. In both the first and the third experiments the alfalfa and clovers which were sown alone in the autumn made a good growth before the winter started, but were badly winter killed before spring. Although the clovers and alfalfa which were sown alone in the autumn in the second experiment did not fare as badly as those of the first and the third experiments, still the results were poor in comparison with those of other seedings. The grasses, the clovers and the alfalfa gave good results when sown in the spring, either with or without a grain crop. The grasses also gave fairly good results when sown in the autumn either alone or with winter wheat. In studying these results, it must be remembered that where the grass and clover seed has been sown with either winter wheat or with oats, there is a great advantage in having the grain crop which is likely to be more valuable, in most instances, than the increase in the yield of the grasses or the clovers when sown by themselves.

SWEET CLOVER SOWN AT DIFFERENT DATES

For five years in succession two varieties, Biennial White and Biennial Yellow sweet clover were seeded in each month of the year.

The seeding in each case took place about the 20th of the month. The highest yields were obtained from those plots which were seeded in the months of March, April and May. The March seeding was made on a late fall of snow or on the bare frozen ground, while the seeding of April and May were made on prepared land and no nurse crop was used. Good returns were obtained from seeding sweet clover alone on a thoroughly prepared seed-bed as late as July 12th but seedings made after July produced comparatively small yields.

Three seedings of each variety were made in April, of which one was without a nurse crop, and one with a nurse crop of barley, and the other with a nurse crop of oats. The plots seeded without nurse crops produced fair yields of hay in the year of seeding, and about one-third greater yield of hay in the second year over those seeded with nurse crops. The total yield of hay produced from the plots which were seeded without nurse crops was about double that produced from those which were seeded with nurse crops. There was very little difference in the yield of hay from the plots seeded with the different kinds of grain nurse crops.

Sweet Clover almost ready to cut for hay. White Biennial Sweet Clover on the left, Yellow Biennial Sweet Clover on the right.

GRASSES GROWN ALONE FOR PASTURE.

Following a large amount of investigation, the Royal Agricultural Society of Woburn, England, as well as other experiment stations of Great Britain, found it unwise to attempt to compare the pasture value of different grass lands by having the crops pastured by sheep unless three acres were used for each plot. If cattle pastured the land even larger plots were considered necessary to obtain accurate results. It will therefore, be seen that pasturing areas of three acres or more of twenty different varieties of grasses would require a large amount of land, more than is available at most experiment stations. However, valuable information on pasture value of different grasses and on other crops may be obtained by using smaller plots of land and by cutting, weighing and removing the crops from the land instead of pasturing them by farm stock. An experiment was conducted at the Ontario Agricultural College for a period of four years in succession by cutting, weighing, and removing the crop produced from each of sixteen varieties of grasses. In the average of four years the crops were cut on the six dates as follows:- May 28th, June 18th, July 9th, July 30th, August 20th, and September 16th. It will be noticed that the growth was somewhat slower between the last two dates than in the earlier periods.

In one of the years of the experiment there were two sets of grass plots containing sixteen varieties. These two sets were fenced separately. They were pastured three times during the summer, one set by a herd of cattle and the other by a flock of sheep. The sheep were turned on the pasture on May 19th, July 3rd and September 14th, and the cattle on May 27th, July 13th, and September 22nd. In each instance the animals were on the pasture about one week. Careful notes were taken of the amount of pasture removed from each plot at the end of the first and of the last day of each period. The experiment was conducted in order to obtain information regarding the palatability of the different grasses for pasturing cattle and sheep. The table following gives the average yields of the four years' results of each of sixteen varieties of grasses cut at six different stages as well as the total number of tons of pasture material per acre per annum and the comparative palatability of the different grasses:-

Varieties. of Grasses	Percentage Palatability as determined by pasturing cattle and sheep. 12 Determinations		Tons of Green Pasture per Acre per Annum from each of Six Cuttings. (Ave. 4 years).						
	Cattle	Sheep	1st.	2nd	3rd	4th	5th	6th	Total 6 cuttings
Tall Oat	77	100	5.93	.83	1.59	1.23	1.33	.87	11.70
Orchard	100	80	4.34	1.71	.92	1.30	1.05	1.40	10.72
Western Rye	37	26	4.82	1.28	.93	1.58	.89	.64	10.14
Canadian Lyme	67	72	3.67	1.81	1.01	1.82	1.01	.73	10.05
Bearded Wheat	41	48	3.18	1.78	1.03	1.89	1.11	.79	9.78
Meadow Fescue	68	53	4.60	1.72	.69	1.09	.84	.61	9.55
Virginia Lyme	43	49	4.13	1.32	.87	1.65	.86	.62	9.45
Tall Fescue	55	55	4.70	1.75	.78	.87	.74	.59	9.43
Timothy	87	92	4.87	1.71	.58	1.11	.62	.49	9.38
Fringed Brome	59	58	4.27	.80	1.09	1.55	.98	.58	9.27
Awnless Brome	81	80	4.53	.96	1.04	1.26	.63	.62	9.04
Perennial Rye	40	42	4.10	1.49	.61	.78	.90	.80	8.68
Meadow Foxtail	88	75	3.81	1.32	.72	.95	.53	.37	7.70
Kentucky Blue	69	87	3.76	1.04	.73	.78	.58	.58	7.47
Rhode Island Bent	59	66	3.17	1.17	.66	.91	.52	.40	6.83
Red Top	63	68	2.71	1.03	.62	.67	.44	.37	5.84

The table shows that Tall Oat grass produced the largest amount of pasture per acre, the average for the four years being over eleven and one-half tons per annum. This grass produced decidedly the largest yield from the first cutting, produced good yields in the middle of the summer and furnished a fairly large amount of pasture crop in the autumn of the year. Orchard Grass in average total yield was a fairly close rival of Tall Oat. It produced its greatest quantity of pasture crop at the first cutting and the second largest at the last cutting. More pasture was produced from the sixth cutting of Orchard Grass than from any other grass in the test. Although Western Rye, Canadian Lyme and Bearded Wheat have all given comparatively high results in yield of pasture per acre, a study of the experiment shows that when these crops are cut six times during the summer, the plant vitality becomes greatly exhausted and the crops are likely to be quite inferior the following season. In the case of Tall Oat, Orchard, Meadow Fescue and Tall Fescue, however, the vitality of the plants does not seem to be injured to any great extent by frequent cutting. The results of these individual tests are chiefly valuable because they help to form a basis for compounding different mixtures of grasses to be sown for the production of pasture.

CLOVERS, OTHER LEGUMES AND SIMILIAR CROPS GROWN ALONE FOR PASTURE.

An experiment was conducted for three years by cutting each of eight varieties of clover and similiar crops at six different times during the growing season in order to ascertain the amount of pasture crop produced by each variety throughout the summer. The first cutting was made as soon as the earliest varieties had furnished sufficient growth to afford good pasture. Each of the other five cuttings were made at such times as the most vigorous growing varieties had produced sufficient growth for pasture purposes. Immediately following each cutting, the crop was weighed in order to ascertain the exact yield of pasture produced by each variety.

In order to obtain the best information regarding the palatability of the different varieties, each of the two sets of plots was enclosed with a hurdle fence. When the majority of the varieties were in the best condition for pasture, a herd of cattle was turned in on one set and a flock of sheep on the other set. The animals were allowed to roam over the plots. Careful notes were taken on the evening of the first and on the evening of the last day of the pasture periods which lasted nearly a week. The process was repeated three times during the season. The average amount of pasture crop removed from the plots and the six observations for each class of farm stock, when worked out in the form of percentages furnishes valuable information regarding the comparative yield and palatability of the different varieties when pastured by cattle and by sheep.

The table below gives the average results for three years of each of six cuttings per annum of each variety, and also the palatability of the different varieties of pasture crops, as determined from six observations made in one season when cattle and sheep were allowed to pasture on the plots:-

Varieties.	Percentage Palatability as determined by pasturing cattle and sheep. 12 Determinations		Average of Three Years' Results in Yield of Green Pasture Crop per Acre from each of Six different cuttings. (tons).						
	Cattle	Sheep	1st	2nd	3rd	4th	5th	6th	Total 6 cuttings
Alfalfa	93	83	8.73	3.06	2.70	3.62	1.56	1.27	20.94
Common Red	99	88	10.88	1.10	2.37	3.39	1.52	1.15	20.41
Mammoth Red	100	100	10.55	1.02	1.99	2.83	1.19	1.19	18.77
White or Dutch	86	93	7.35	2.35	1.95	1.91	2.08	1.63	17.27
Alsike	98	96	8.22	.28	3.06	1.41	2.56	.93	16.46
Yellow Trefoil			5.07	.19	2.59	2.18	2.10	1.02	13.15
Sainfoin	88	74	4.64	.67	1.78	2.73	1.19	.79	11.80
Burnet	88	69	2.64	1.39	1.05	1.52	.59	.41	7.60

It will be noticed that the pasture that was the least relished by the sheep was produced by Sainfoin and Burnet, and that least relished by the cattle, from White or Dutch Clover, Sainfoin and Burnet. Mammoth Red Clover proved to be the most palatable for both classes of stock. It will be noticed that alfalfa produced an average total yield of over twenty tons per acre. Alfalfa is a good pasture crop when care is taken to see that it is not too closely pastured or pastured too early in the spring or too late in the autumn. White or Dutch Clover produced a surprisingly large yield. This clover, which does not grow nearly so tall as most of the other clovers, makes a very compact pasture and usually yields more than its appearance would indicate. The results of this experiment should be considered along with the figures previously reported for the grass varieties grown alone for pasture.

SINGLE CROPS AND MIXTURES FOR ANNUAL PASTURE

It frequently happens that owing to severe winters, ice conditions in the spring, and other causes that the farmer faces a shortage of pasture during the summer months. A large amount of experimental work has been conducted at the Ontario Agricultural College in testing the value for annual pasture of different crops grown singly and in mixtures. In an experiment conducted in duplicate for a period of five years, fourteen crops were sown singly. One set of the fourteen plots was used in determining the comparative earliness, resistance, rapidity, and persistency of growth, and yield of the different crops, and the other in determining the palatability of the crops when pastured by farm stock.

In one set each crop was cut at the end of six, nine, twelve, fifteen and eighteen weeks after the seed was sown, thus making a total of five cuttings for each crop. By weighing the green material obtained in each instance, immediately after it was cut, information was obtained regarding the approximate amount of green pasture material from each crop throughout the season.

The other set was sown in exactly the same way as the one already described, but the fourteen separate crops were pastured by a small herd of cattle instead of being cut and weighed every three weeks. When the crops were in their best condition for pasture, the cattle were turned on and allowed to roam over the plots. Careful notes were taken of the approximate amount of pasture consumed on each plot at the end of the first day and also on the last day of the pasture period. This lasted about one week. This was repeated from two to three times each season in each of three years and furnished valuable information regarding the palatability of the crops for pasture purposes.

The following table gives the average percentage of palatability determined from pasturing cattle on the plots and also the production of pasture material obtained from the different cuttings of each of fourteen crops:-

Varieties.	Percentage Palatablity as determined by pasturing Cattle 3 years. 16 Determinations	Average of Five Years' Results in Yield of Green Pasture per Acre from each of five different Cuttings (tons).					
		1st	2nd	3rd	4th	5th	Total 5 cuttings
Oats	100	3.61	2.73	1.16	.72	.51	8.73
Red Clover	67	.05	2.15	2.70	1.97	1.73	8.60
Hairy Vetches	67	1.04	3.85	1.17	1.30	.89	8.25
Sorghum or Sugar Cane	82	.11	2.00	3.20	1.43	.94	7.68
Pasture Rape	90	.61	3.98	1.08	.97	1.01	7.65
Crimson Clover	66	.04	2.49	2.48	1.05	1.57	7.63
Spring Rye	22	5.54	.71	.37	.51	.28	7.41
Barley	89	3.91	1.55	.58	.33	.43	6.80
Hungarian Grass	58	1.01	2.98	1.24	.97	.33	6.53
Common Vetches	62	1.54	2.31	1.01	.92	.66	6.44
Grass Peas	63	1.56	2.78	.77	.38	.24	5.73
Flint Corn	96	.77	2.31	1.72	.64	.01	5.45
Goose Wheat	74	2.18	1.62	.78	.27	.33	5.18
Soy Beans	52	.64	1.26	1.05	.69	.41	4.05

The results in the above table show that oats are the most palatable of the different crops under test and that flint corn, pasture rape, barley, sorghum and goose wheat were all readily eaten by cattle. Red clover, hairy vetches, crimson clover, grass peas and common vetches did not prove to be as palatable as those just mentioned, while Hungarian grass, millet, soy beans and spring rye appeared to be the least relished of the crops under test.

Oats furnished its largest crop of pasture early in the season while red clover furnished a larger amount of pasture material than any other crop towards the end of the pasture period. Hairy vetches and pasture rape gave the largest yield of pasture crop at the second cutting, and the Early Amber Sugar sorghum the largest amount of pasture material at the third cutting. Early Amber Sugar sorghum is a plant which stools heavily and usually gives good results for pasture in the hot dry time of summer. Barley did not produce nearly as large yields per acre of pasture as Oats. There seemed to be little desire on the part of animals to touch the barley pasture once it had started to head. Goose wheat besides being low in palatability did not seem to be well adapted for pasture purposes.

From the experience in growing different crops in mixtures for hay production it was realized that for pasture purposes better results would probably be obtained if annual crops were grown in mixtures rather than grown separately. An experiment was, therefore, conducted by using six different combinations of three crops each. These six mixtures were tested in duplicate in each of five years. Each mixture was cut at the end of six, nine, twelve, fifteen, and eighteen weeks after the seed was sown, thus making five cuttings of each crop in the season. The table below gives the amount of pasture material obtained from the different cuttings of each of the six mixtures.

Mixtures	Average of Five Years' Results in Tons of Green Pasture per Acre from each of five different cuttings. (10 tests).					
	1st	2nd	3rd	4th	5th	Total 5 cuttings
1. Oats Sorghum Hairy Vetches	2.95	3.73	1.84	1.14	1.01	10.67
2. Oats Hairy Vetches Crimson Clover	2.92	3.54	1.74	1.21	1.00	10.41
3. Oats Sorghum Red Clover	2.73	3.13	1.18	1.18	.85	9.12
4. Emmer Hungarian Grass Red Clover	2.46	2.28	1.06	1.10	.66	7.56
5. Emmer Sorghum Red Clover	2.30	2.09	1.14	1.12	.72	7.37
6. Spring Rye Emmer Hungarian Grass	4.43	1.06	1.06	.55	.22	7.32

In compounding these mixtures the aim in each case was to have a natural succession of crops and a continuous supply of pasture in the late spring, the hot dry time of summer and also in the autumn. Each of the three first mixtures produced a large yield of pasture material which was well relished by farm stock.

As a result of testing the different crops both singly and in combination it was decided to make use, in a more extensive way, of a mixture of oats, sorghum and red clover as an annual pasture. For this purpose, the following quantities were used:-

Oats	51	pounds	per	acre.
Sorghum	30	"	"	"
Red Clover	7	"	"	"
Total	88	"	"	"

The oats and sorghum were mixed together and were sown from the grain box of the grain drill while the clover seed was sown from the grass seed box placed in front of the tubes of the drill.

An area of between eight and ten acres has been sown of this mixture for pasture purposes in the Department of Field Husbandry in each of fourteen years. Seeding has usually taken place about the end of the first week in May and the crop has been ready for pasture in about six weeks' time. This crop was pastured with milch cows for three years, with heifers for three years and with steers for five years. When the steers were pastured they were weighed once a month and were removed from the pasture at no other time. At the end of five years in which careful records were kept it was found that on the average one steer would require four-fifths of an acre, or five steers would require four acres for the season. The increase in live weight of the animals was 2.6 pounds per head per day. The annual pasture crop was not supplemented by any other kind of feed. In no instance was there any trouble from bloating and the animals kept in excellent health and in fine condition while on the pasture. Tramping did not injure the soil in the field to any serious extent. All three crops in the mixture withstood the tramping of the animals satisfactorily. In all but one year there was a successful catch of clover which could have been left over winter to furnish hay or pasture the following season.

In the last several years the following combination has given excellent results at Guelph as an annual pasture mixture:—

Oats	80	pounds per acre.
Biennial White Sweet Clover	20	" " "
Total	100	" " "

A June Excursion crowd examining Experimental Plots at Guelph. Annual pasture mixture on the right (80 lbs. O. A. C. No. 7-2 oats and 20lbs. White Biennial Sweet Clover sown per acre).

This mixture is ready to sow as soon as the land can be properly prepared in early spring and is usually ready to pasture in about six to seven weeks after seeding. The oats provide the larger part of the pasturage in late spring and summer, while the sweet clover makes up a very considerable percentage of the pasturage in late summer and autumn. In using such a combination as the one mentioned above it is essential that a large strawed oat be used. The O. A. C. No. 144, O. A. C. No. 72 or Banner varieties are well suited for use in such a mixture. It is important that seed of sweet clover be scarified before sowing. One of the chief reasons why sweet clover volunteers in crops that follow it is that the seed sown has not been scarified and the hard seeds do not germinate in the same season they are sown. The sweet clover of this mixture may be allowed to winter over and provide a pasture crop the next season or be used for silage or other purposes.

One of the principal advantages of this annual pasture mixture over the one containing the Early Amber Sugar Sorghum is that the seed of White Biennial Sweet Clover is much cheaper than that of Early Amber Sugar sorghum. In some seasons too Early Amber Sugar sorghum is apt to be low in germination.

TEMPORARY PASTURE MIXTURES.

While single crops are occasionally used to produce temporary pasture, farmers usually sow a mixture of one or more varieties of grasses and one or more varieties of clovers or other legumes for this purpose.

In some instances sweet clover, common red clover or mammoth clover may be sown with a grain crop with the object of producing either hay or pasture in the following year, after which the land is again brought into cultivation. Legumes used in this way are suitable for a three years' rotation; a cultivated crop, grain crop and a hay or pasture crop. When a farmer is compounding a mixture for either a temporary or permanent pasture he should consider the cost of seed, the ease with which these may be sown, and also the time he intends to leave the land in sod. A mixture of timothy and common red clover is undoubtedly used more extensively than any other combination and is generally suitable for two years of hay and pasture. Unfortunately, however, it has been a common practice with farmers, largely due to scarcity of labor, to seed their grain with timothy and common red clover and after taking off one crop of hay, to use the land for pasture for a number of years. The clover soon disappears and the timothy forms a comparatively poor pasture especially in hot dry summers. When it is the intention to use the mixture for pasture for a number of years it is usually wise to add a considerable quantity of some of the hardier grasses which withstand the hot dry time of summer. The following combinations of grasses and clovers are suggested as being suitable for temporary pastures and in some cases for annual pasture purposes. The amount of seed per acre recommended is given in each case.

Common Red Clover	8	12 pounds of seed per acre.
Timothy	4	
Common Red Clover	6	12 pounds of seed per acre.
Alsike	2	
Timothy	4	
Common Red Clover	6	18 pounds of seed per acre.
Alsike	3	
Timothy	3	
Orchard Grass	3	
Meadow Fescue	3	
Alfalfa	6	20 pounds of seed per acre.
Common Red Clover	3	
Alsike	2	
Timothy	3	
Orchard Grass	3	
Meadow Fescue	3	

The first two mixtures would be suitable for a period of two years, the third mixture for a longer period and the fourth mixture could, when necessary, be used as a permanent pasture.

When the land is low and comparatively wet these combinations could be improved by the addition of Red Top grass, and the adding of more Alsike to the mixture.

These mixtures usually give their best results when sown in the spring with a nurse crop of grain, the nurse crop being seeded at the rate of not more than two-thirds the quantity used when no grasses or clovers are sown. Seeds of grasses and clovers do best when sown in front of the grain tubes. This provides for an even distribution of these small seeds and they are not buried too deeply.

PERMANENT PASTURE MIXTURES.

More pasture per acre and pasture of better quality would be produced in Ontario if farmers paid more attention to the grasses and clovers sown for permanent pasture. It frequently happens that fields which are remote from the buildings on the farm, can be sown with a permanent pasture mixture, to excellent advantage. Often fields lying quite close to the buildings, because of shape, size or some other cause do not fit conveniently in the rotation and could to advantage be sown to a permanent pasture mixture. A very large amount of experimental work has been carried on during the last forty years at the Ontario Agricultural College in testing the value of different grasses and clovers both singly and in combination, for permanent pasture. The following are three of the best of the permanent pasture mixtures tested:-

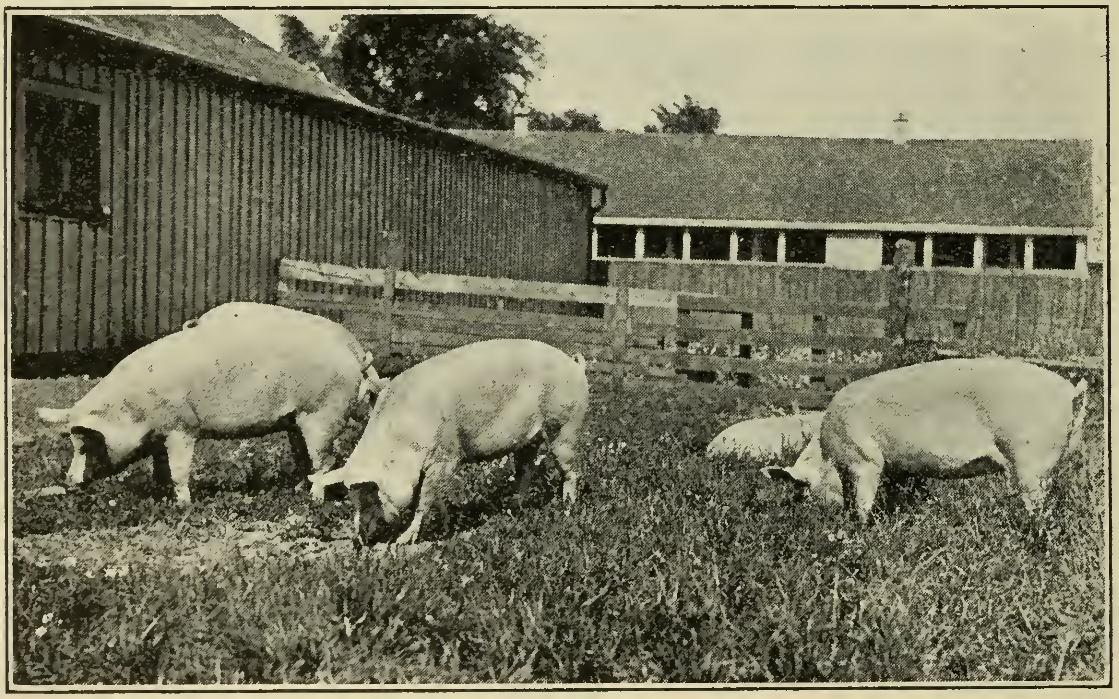
Orchard Grass	4	24 pounds of seed per acre.
Meadow Fescue	4	
Tall Oat	3	
Timothy	2	
Meadow Foxtail	2	
Alfalfa	5	
Alsike	2	
White or Dutch Clover	1	
Yellow Trefoil	1	

Alfalfa	6	24 pounds of seed per acre.
Alsike	2	
White or Dutch Clover	1	
Timothy	3	
Orchard Grass	6	
Meadow Fescue	6	

Meadow Fescue	6	35 pounds of seed per acre.
Meadow Foxtail	3	
English Rye	2	
Timothy	3	
Canadian Blue	4	
Orchard Grass	3	
Red Top	2	
Yellow Oat	2	
Alfalfa	4	
White or Dutch Clover	2	
Alsike	2	
Red Clover	1	
Yellow Trefoil	1	

The mixture which required thirty-five pounds of seed to sow an acre did not produce as much pasture per acre as the two mixtures which each required twenty-four pounds of seed to sow an acre. This was due largely to the fact that the mixture requiring thirty-five pounds of seed to sow an acre contained a number of small growing varieties of grasses.

The seed of permanent pasture mixtures can be sown in the early spring with or without a grain nurse crop. They usually do best when they follow a cultivated crop which has been carefully handled during the previous season. When the seed has been sown alone without a nurse crop it is often a good practice to cut the tops of some of the taller growing grasses and allow these to lie on the ground in the form of a mulch. When a nurse crop is used, one bushel of barley or one bushel of spring wheat can be recommended. Oats because of greater stooling tendency usually do not make as satisfactory a nurse crop as the two grains mentioned. In these mixtures some of the heavier weighing of the grass seeds are sown from the grass seed box and some of the lighter such as Meadow Foxtail, by hand.



Hogs on the College Farm pasturing on a mixture of Grass and Clovers (Red Clover 6 lbs, Alfalfa 4 lbs, Alsike 2 lbs and Timothy 4 lbs per acre). A good hog pasture materially lessens the cost of production.

The most desirable combination for permanent pasture are hardy grasses and clovers, and these when once well established on suitable land will produce good yields of pasture, high in quality, palatable to animals and permanent in character. It should be remembered that permanent pasture mixtures because of the larger quantities of seed sown cost more per acre to sow than temporary pastures and therefore only the most suitable grasses and clovers should be used in mixtures of this kind.

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Amateur Dramatics

By Mrs. E. C. McLean, M.A., B.E.,
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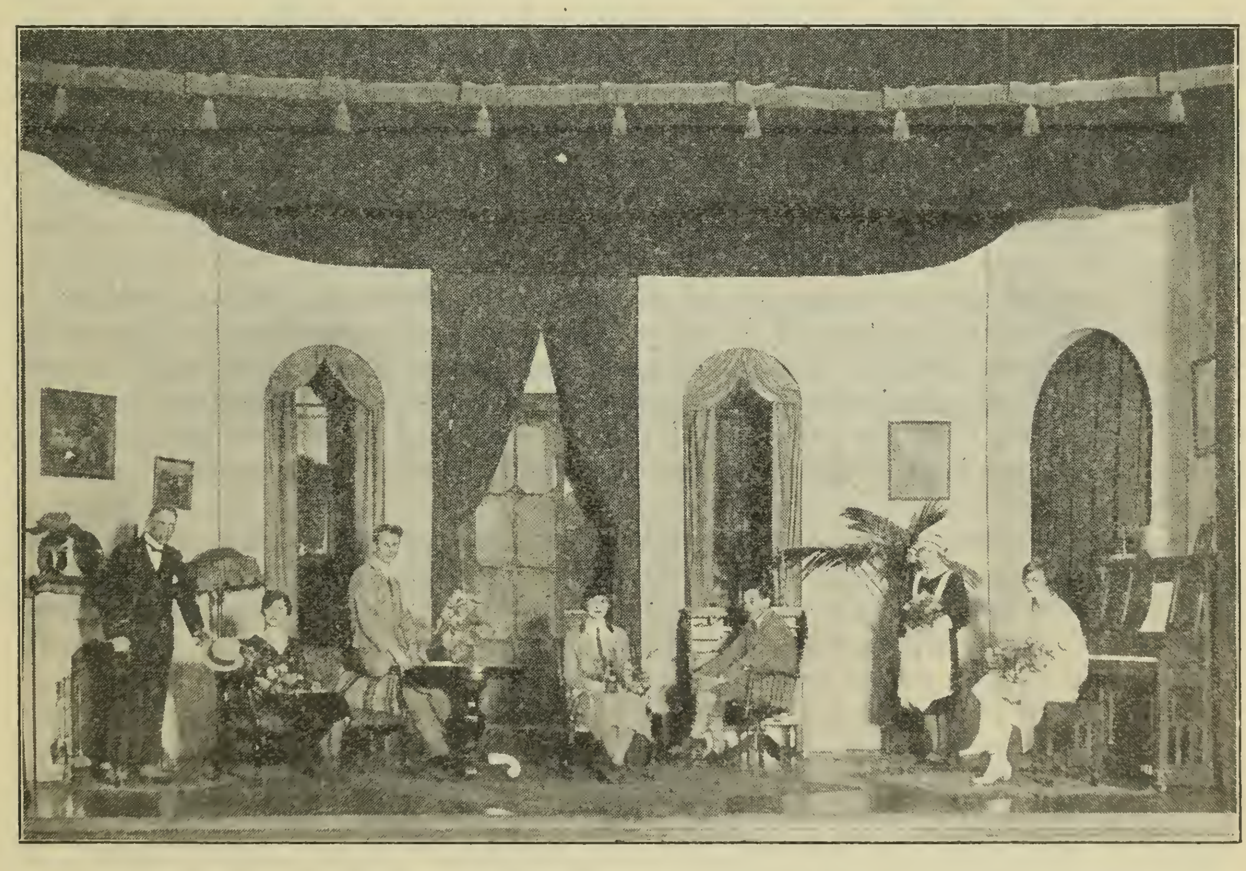
INTRODUCTION

The production of plays by amateurs is by no means a recent development; groups of amateurs were producing plays in England before Shakespeare was born. Recently, however, interest in amateur dramatics has been on the increase. In Ontario at the present time this increased interest is particularly noticeable in rural communities. Plays are being put on in communities where they were never attempted before, and in other communities, where the production of plays has been going



The Cast of "Mr. Pim Passes By" as Presented by the O.A.C. Philharmonic Society.
Note the stage set which is made of flats and arches. The two smaller arches are curtained and taped to represent windows; the larger arch is the left side exit.

NOTE.—Mrs. McLean has been identified with the Philharmonic Society of the Ontario Agricultural College for the past five years. She has successfully directed a number of plays which have been presented by this student group. She has made a study of the subject and has given large assistance in the preparation of this bulletin.

on for some time, the attempt is being made to put on better plays and to present them more effectively.

While not all parts of this bulletin will be equally useful to all readers, it is hoped that the material presented may be of some value both to those who are beginners in the art of play production and to those who have already had some experience. Particular attention is directed to Sections I and VIII dealing with the choice of a play; this seems to be a matter of difficulty for many groups of players.

I. THE CHOICE OF A PLAY

Who is to choose the play to be presented? It may be an individual whose judgment can be relied on, or it may be a committee composed of prospective players or others interested in play production. If a simple organization such as that described in the next section can be formed, it will be wise to leave the choice to the director, the business manager, and the stage-manager. In whatever way the play is chosen, the director should be consulted before any definite decision is taken; he cannot be expected to do good work on a play which he is not in sympathy with or does not understand.

Royalty and Non-Royalty Plays

Use good plays. The best cook in the world cannot be expected to make satisfactory cake if supplied only with second-grade butter, and middle-aged eggs. The good play gives parts that are much easier to act convincingly, because the character is clear and easily understandable. It is easier to present, because it has good stage action and a good story. It is easier for the coach, easier for the actors, and will in the end be more enjoyable for the audience. Do not be afraid to try a good play because of the old idea that only the broadest sort of comedy will please your audience. As a rule you will find that any good play will succeed if only it be done well enough.

One way of testing the quality of plays done locally is to compare them with the average movie. Are most of the plays put on in your community as interesting as a good average movie? Less so or more so? Given your choice which would you prefer? If you are inclined to choose the movie, then decidedly there has been something wrong with the selection of plays. Any good play done with average ability should be decidedly more interesting than the majority of motion pictures we see.

Good plays are usually, as you would expect, more expensive than trashy ones. Most good plays are royalty plays.* Exceptions include the older plays such as those by Shakespeare, Goldsmith, Sheridan, and Molière. It is a mistake to choose these in order to avoid expense, as they often require costumes that must be rented at five to ten dollars apiece and in the end may cost more than royalty plays.

Any group of players who present a royalty play without securing the proper permission and paying the authorized fee render themselves liable to prosecution. *For non-charge or charity performances royalties are frequently remitted or reduced.* In writing about royalty the business manager should state clearly whether for a charge or non-charge performance, and the purpose, if of any special nature, to which the proceeds are to be applied.

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*Workers have to be paid for their labors. The garage man could not make a living unless he charged for his work. The playwright is no exception to the general rule. The majority of plays are written to be acted, not to be read as books, and the writer's pay for his work is derived from a fee charged for acting the play. This fee is known as a royalty and runs all the way from $5.00 to $50.00. The paper-covered books sent out as acting copies are printed in comparatively small numbers, and the writer derives little, if any, profit from their sale.

SELECT TO SUIT LOCAL CONDITIONS

The play should be selected to suit local conditions, considering the taste of the audience, the ability of the coach, the talent to be had amongst the prospective players, and, of course, the amount which can be afforded for royalties.

Some general hints may be given:

If you have someone who can do good comedy or eccentric parts ("character-acting"), look for a play which gives him opportunity. If your best player is a woman, choose a play with a woman for the central character.

If you have a man who is handy with a paint brush, choose something that will give him an opportunity to do some really good work on the scenery or stage setting.

If your stage facilities are poor and your stage-manager is weak, choose a play requiring only one set of scenery.

If you have no outstanding actors and wish to make sure of holding the audience, choose a play with great story interest of the thriller or mystery type. This might also apply if your coach is weak.

ADVANTAGES OF THE ONE-ACT PLAY FOR BEGINNERS

For beginners one-act plays have many advantages. Two or three one-acts can be presented in one night if it is desired to give a complete evening's performance. Two with some musical selections provided between would make a very satisfactory evening.

If you have many people who are anxious to play, the one-acts would possibly give them all an opportunity. Furthermore, one-act plays are an excellent way to break in new talent. The timid, inexperienced player who would never consider a part in a longer play may frequently thus be induced to appear and may find through his experience in the short play that he has considerable ability. The one-act plays give the coach an opportunity to try out a larger number of players. They also mean less expenditure for royalties. Many can be had for a royalty of five or ten dollars; thus two one-acts will cost considerably less than a good long play and are much more satisfactory than a cheap long play. Last but not least, the one-acts by their variety give an opportunity of pleasing a larger percentage of the audience. One of the plays selected may be light comedy and the other something mysterious, grotesque, fanciful, or seriously dramatic to appeal to an entirely different type of taste.

Variety in program is one of the best means of keeping up popular interest; even burlesque will become monotonous if nothing else is seen. This should be remembered in planning programs over a number of years and in choosing three-act as well as one-act plays. For further assistance in selecting plays, consult the lists given in Section VIII.

II. ORGANIZATION

If amateur dramatics are to be made a success, there should be at least two responsible officials in charge of each production. What is everybody's business is nobody's business, and many attempts at play production fail just for lack of some simple form of organization. If there can be found three or four reliable people who are willing to assist though not themselves playing, so much the better. They should be used in the following positions: Director or coach, stage-manager, assistant stage-manager, business manager.

If two persons only can be found, one should act as director and the other should be both stage-manager and business manager. By all means find one person at least to assist before beginning any production. Below will be found an account of some of the duties of these officials. This material may be of more interest to the individuals concerned than to the general reader.

THE DIRECTOR

Amateur groups frequently attempt to work up a play with no definite director in charge or with someone directing who is also playing. This is a mistake; even on the professional stage it is seldom that the director takes a part in the play. Since we are unable to see ourselves when we are on stage, we need someone who will remain out in front to watch, direct, and criticize. One should no more think of attempting to put on a play without a director than of attempting to buy clothes or hats without an opportunity of seeing them in a mirror. Group together the best musicians in the world, and you will never have a good orchestra without a competent conductor. And so with playing; even though the actors may be perfect individually, a director is needed to get the necessary team-work.

Is there anyone in your community who is interested in plays but not in acting? Such a person might well be considered as a possible director. The best coach is often someone who might not act well, but he should be interested in plays, and preferably know something about them. What he must have is critical ability. He must be willing and able to point out defects. The man who always says, "That's fine!" is of no use as a critic. When you have a coach who is able to tell you exactly what is wrong, don't be vexed, but give thanks that you have a good coach.

Great care should be exercised in the choice of a director, but once he is chosen he should be obeyed. His should be the final word in regard to the choice of a play, the selection of the players, and the stage business.* He must be able to cooperate with the stage-manager in preparing the necessary scenery or stage "sets". Before the first rehearsal he should have studied the manuscript closely and planned the stage sets and all business; and he should have in his own mind a definite mental picture of each character in the play. In planning business he should keep complete notes of his ideas in the margins at each side of the page in his copy of the play.

The director should not be slavishly bound by the printed book, either as to business or lines. The business must be changed to suit the stage and the ability of the actors. Judicious cuts in lines are allowable to avoid long-drawn-out, "talk" scenes which may be difficult for the players or for the audience.

In addition to the local coach it may be well, if you can afford it, to get in expert assistance, particularly if the local coach is weak. The important points on which help is most likely to be useful are:

Casting, that is the selection of the players.
Setting-up, that is working through the play for the first time and determining or "setting" the stage business.
Dress rehearsals.

It should be possible to get a price from the nearest expert coach for assistance in just these three matters, leaving the local coach to do all the other work.

THE STAGE-MANAGER

In almost every community if you look thoroughly you will find someone who is fond of drawing or painting or who likes to try his hand at amateur carpentry, and who possibly gets as much fun from that as the players do out of acting. Find him and make him, preferably, your stage-manager; or, if he is a type lacking entirely in executive ability, make him assistant stage-manager.

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*Stage business is the term applied to all motions on stage—crossing left to right, back to front, standing, sitting, smoking, sewing, and the expression of emotion without speech in response to what other actors are saying. As such business is never given completely in the printed play, one of the most important of the director's duties is thinking out the business of each character, in so far as possible, before rehearsals begin. Any ideas which players may have as to business for their parts should be suggested to the director and left to his discretion.

The main business of the stage-manager is to look after the scenery or "sets" and the properties (tables, lamps, and all other articles required on the stage). His business includes:

1. Planning the sets in cooperation with the coach and the business manager.
2. Working up the sets while the coach is taking "setting-up" rehearsals. This will mean locating and assembling properties and scenery.
3. Actually putting all properties on stage with the complete stage set for final rehearsals.

The stage-manager should be a man with considerable executive ability. He should not only know what he wants, but be able to explain his wants clearly to others. Above all, he must know the value of time. More amateur shows are killed by lack of, or by poor stage management than by poor acting. In going to see "Lighthouse Nan", one doesn't enjoy hearing the hammers begin pounding for the erection of the lighthouse fully twenty minutes after the time advertised for the show to begin. Delays between acts should be made as short as possible. Twenty minutes should be the outside limit; and that should be exceptional. Aim for ten to twelve minute intervals, and a prompt opening curtain.

THE ASSISTANT STAGE-MANAGER

The assistant stage-manager should act as a general assistant to the stage-manager, and he may also be used as a prompter both at rehearsals and on the final night. If it is desired to use a minimum number of people in executive work the assistant stage-manager may also act as business manager. This can easily be arranged as the business manager's work is practically all done ahead of time. Combining the two positions may lead the man filling them to take more interest in his work, as he will feel his place in the organization to be an important one.

THE BUSINESS MANAGER

The matter of keeping down costs is important in most communities; hence the importance of having a good business manager. The following is a list of some of his chief duties:

1. To begin with he should make on paper an estimate of all the money to be spent—what can be afforded in view of possible receipts. This may include: Royalties, cost of books, cost of coach if one is to be hired, rent of hall, advertising, programs and tickets, setting, costumes and make-up. Some of these items of expense are avoidable. For example, one may dispense with programs and tickets by having the cash collected at the door and announcements made from the platform.
2. After the play is selected the business manager should send for the necessary books and arrange for the royalties.
3. He should confer with the coach and stage-manager to see that expenses are kept within bounds and do the ordering the stage-manager requires for set and properties.
4. He should arrange for places for rehearsal, and for an outside coach, if used.
5. He should look after the advertising, printing of programs and tickets, and the rent of the hall. In regard to advertising it may be possible to find someone who will make the posters without charge. The stage-manager or the man who is working at painting scenery might be able to do this.
6. For the night of the performance he should arrange for ticket sellers and ushers. The ushers should be warned to wear rubber-heeled shoes and should not allow the entrance of late-comers to interrupt the performance. Interruption may be avoided by having those who are late sit at the back of the hall as they come in, and taking them down to their seats by twos or threes, not in crowds.
7. After the performance he should take charge of the money, balance up expenditures and receipts, and, if necessary, bank the money or hand it over to a permanent treasurer.

III. CASTING

The selection of players to fit the different characters of the play is called casting. Casting must be done scientifically. It is a great mistake to use friends merely because they happen to be friends, or enthusiasts just because they happen to be enthusiastic. Have the group understand at the very beginning that they will be asked to read selections from various parts to discover which, if any, they are best suited for. After that they may, if necessary, be asked to read and study a part for several days and then to read aloud again before any final choice can be made. This ensures finding the best player for each character.

Try-Outs

Everyone interested should have an opportunity to read the play before trying out. This means that the required number of copies must have been secured in good time by the business manager. At a general meeting the director will call on each candidate to read several parts and may assign parts for special study for the next few days. Another meeting may then be called to settle things. The director should encourage those not used to try again for parts, and he should try later to pick a play which may give them some opportunity if they seem to have any real ability.

Hints for the Director

In casting the play the director must have the final word. Others can best help by getting out types for him to select from. He should try to pick someone who suits his idea of the part. Don't put young people into old parts, or old people into parts which call for youth. If you want a dominating personality on the stage, don't pick someone who is shy and backward in real life. And don't pick the dominating personality of your community to play the part of someone who is supposed to be diffident and awkward. It is wise to try to hand around the honors in a playing group—not by choosing any but the best for each play, but by choosing a variety of plays which will give all a chance. Don't hesitate, however, to use always the best material available, whether used before or not.

If you have enough people interested to be able to carry understudies, you will be wise to do so. The director in that case would make a first and second choice for every part and have the understudies present at all rehearsals until lines are memorized and business set up. After that the understudy should be ready at call. This ensures an excellent *morale* in the cast. In case of sickness or at any signs of slacking on the part of a player, the understudy can be called upon at once. The mere threat to do this may have a very salutary effect. Understudies not used otherwise may be called upon to act as ticket sellers or ushers the night of the performance.

IV. THE PREPARATION OF THE PLAY

It is much the best plan to call rehearsals *every night* and get down to business at once. The attempt to combine the preparation of a play with having a good time socially is bound to mean that one or the other will suffer. Let playtime come before or after, but not during rehearsal. "Sociable" rehearsals held twice a week for six or eight weeks will never give a play the same finish as three weeks of intensive effort with rehearsals at least four or five times a week. Furthermore, if rehearsals are to be drawn out over a couple of months, there will always be found one or two in the cast who will be inclined to put off their work and miss the earlier rehearsals, thinking that there is still plenty of time ahead. Such a spirit is likely to spread through the cast, and it becomes very difficult to get a complete rehearsal at all until just a night or two before the performance. If it is planned to use just the time needed to prepare the play efficiently, the players will realize that they must work hard from the very beginning, and it will be much easier to get concentration on the job in hand.

PRELIMINARY READING

The first step in the actual preparation of the play is what is known as a play-reading. This means that the cast should be assembled, together with the understudies, who will form the audience. Books are distributed and a complete reading of the play aloud by acts is begun, each player reading his own part.

This play-reading serves to get the actors acquainted with each other (if this is necessary), to give them their first conception of the whole play, and to let each understand how his part fits into the whole. This preliminary reading should be done with a dictionary at hand; words whose meaning is not understood should be looked up, and any of doubtful pronunciation should be verified. The meaning of any difficult passages should be discussed and decided on. This makes the first meeting a regular study session, and the more seriously it is taken the better for the success of the play.

SETTING-UP

Setting-up rehearsals mean those rehearsals in which but one act is taken at a rehearsal and that carefully worked through as to entrances, exits, and absolutely all stage business. Each player should bring his copy of the play and a pencil and be prepared to mark in the margin each bit of business given to him. If the play has more than one act, several days will elapse before the act will be repeated, and even the best of memories is not proof against that lapse of time. Learn to depend, therefore, on your marginal notes, and memorize the business noted there at the same time you memorize the lines.

The prompter should, of course, be present at these rehearsals and make careful notes in his book of *all* business for *all* actors. He will then be able to prompt business as well as lines.

MEMORIZING REHEARSALS

Rehearsals of the second round are called memorizing rehearsals because by that time all the actors should have the words sufficiently well in hand to set their books aside and to go through their parts with the assistance only of the prompter. Real acting can only come when the lines have been so thoroughly memorized and so often gone over that they are recalled unconsciously and automatically. The player's mind is then free to concentrate on the character he is creating and real life will come into the part. Really good actors have been known to do poorly in certain plays just because of a lack of this early memorization. They played well in rehearsals as long as they kept their books at hand; but when the books had to be discarded in last-night rehearsals, they were hopelessly tied up thinking of lines. Memorizing is a bugbear for almost all players, but it is one that it pays to get through with as soon as possible. Don't try to cling to your book as a drowning man in mid-Atlantic might cling to a raft. See that your ship is seaworthy before you set out from port.

DRESS REHEARSALS

At least two and possibly three dress rehearsals should be held before the final performance. The director must insist on having complete dress rehearsals. The value of these comes out particularly in scenes where people have to manage wigs, mustaches, old-fashioned costumes, etc. But they are equally necessary where smoking, sewing, tea-serving, singing, whistling or piano-playing are required. Even lighting a cigarette or pipe on stage may become a very awkward matter for a nervous player, unless previously rehearsed. It is especially important that changes of costume between acts should be gone through completely. Otherwise the man who has never rehearsed getting into a boiled shirt may tie up the show on the final night for twenty minutes.

The matter of checking make-up and lights is one of the director's most important tasks in the first two dress rehearsals. If the lights are too strong, faults in the make-up will show up; if the lights are too dim, the make-up may prove too weak to carry. Lights and make-up must be adjusted to suit each other.

All properties should be provided for and used in each dress rehearsal. All changes of set which will have to be made on the final night should be made completely in dress rehearsals and each change should be timed. Only thus has the director a check on what the waits between acts will be. Long waits that show up in the first dress rehearsal and cannot be remedied in the second mean that some simplification of sets is imperative.

The Night of the Show

On the night of the final performance the stage-manager should have his set for the first act as complete as possible well before the time for the audience to arrive. The players should be on hand at least one hour before the curtain is supposed to rise, and more if the costumes are elaborate or the making-up is likely to be a slow process. Once costume and make-up are complete, the player should stay off stage until notified by the director that the opening curtain is due. Otherwise players are likely seriously to handicap such last-minute work of the stage men as is unavoidable. Players should avoid peeping out around curtains or doors while the audience is arriving. The audience has come to see a play, not a peep-show.

V. POINTERS ON ACTING

Getting in Character

To play a part well you must live the part you are playing. This means mentally getting in character well before the actual rehearsal commences and keeping your character in spite of interruptions throughout the whole rehearsal. This is by no means easy. The director will interrupt to have parts repeated; you will forget a cue and will have to appeal to the prompter; the stage-manager may have to change set or properties. If in spite of all this you can keep mentally in your stage character, you are well on the way to really good acting. Some of the best amateurs are distinguished by being in character even in the way they take off their coats on entering a hall for rehearsal and put them on again in leaving. An eminent professional has said that he is always in character for fifteen minutes before going on the stage and for another fifteen minutes after coming off.

"Feeding"

The technical term "feeding" indicates something that deserves more of the amateur's attention than it generally gets. Most beginners seem to have an idea that they are important on the stage only when they are speaking. This is by no means so; in fact, they are frequently least important then. In ordinary conversation when a friend speaks to you you give him your attention, showing your interest in what he is saying by your whole attitude, and responding appropriately by your manner to what he says. So it must be on the stage. How can an actor deliver his lines with any feeling if the player he is addressing behaves like a wooden image? It is simply impossible. Actors *must* work together, respond to each other's lines, "feed" each other. "My, what a feeder!", said one critic, of Sarah Bernhardt, and seemed to find therein her claim to greatness.

Pick Up Your Cues

In every-day conversation we are not given to allowing much time to elapse between speeches. Ordinarily what our friends have to say starts in us a course of thought which we are eager to express at the first opportunity, possibly even making an opportunity by interrupting them. So it should be with stage conversations; yet how frequently a play *drags*, each actor waiting patiently for his own cue, and then when it comes allowing a whole minute to elapse to make sure he "has it right" and that the other person is really finished speaking. Perhaps there is no better way of branding the play as the work of beginners. One of the first things the professional producer works on is "quicker pick-up", "rapid-fire give and take", so that that audience is allowed no time to go to sleep between the lines.

Be Natural

The stage as we now regard it is simply a room from which one wall has been removed so that the audience can see what is happening there. This conception naturally destroys at one stroke some of the "basic old-time stage principles"—for example, the tradition of "talking front". Actors in amateur productions have been seen to address long speeches directly to the audience while the person with whom they were supposed to be conversing stood somewhere in the rear of the stage. How often does one do this in real life? Usually one looks toward the person one is addressing. Exceptions occur when one is engaged in some specific task such as sewing, reading, or playing solitaire, in which case the conversation is likely to be of a desultory nature, or when one deliberately avoids meeting the listener's eyes, in which case one generally busies oneself with some apparently absorbing occupation. To turn one's back on the audience is not a cardinal sin provided one can still be heard.

Other Hints

In cases where weakness of voice or faulty acoustics in the hall make complete naturalness difficult, some stock devices may help the speaker by giving him a chance to face the audience for a great deal of what he has to say.

1. A man may smoke and in the process turn alternately to the person he is addressing and to the audience.
2. A woman may face the audience as she sews and occasionally glance across her shoulder at a companion.
3. The player may be glancing through a magazine or looking over a newspaper and so facing the audience while speaking to other characters.

These devices are also useful in long "talky" scenes if players are inclined to feel self-conscious and do not know what to do with themselves.

Final speeches of the character leaving the stage are frequently best taken from the side of the stage close to the exit. An awkward effect is often produced if the player takes his final speech in the centre of the stage and then has to walk across the stage on his way out.

VI. STAGE SETTINGS; MAKE-UP; LIGHTING

Properties

The stage-manager should start work just as soon as the cast, in consultation with the director and business manager. Sets should be definitely designed and diagrammed* so that each of these three has a copy. The director can then set up his business knowing what he is going to have on the stage, and the stage-manager can locate or make the needed parts of the set without having to come back to the director.

The stage-manager must, above all things, be systematic. He should first make a complete list of all the properties needed, both for the stage sets and for the actors. Without such a list it is very easy to overlook the apparently trivial things which may really be of great importance, for example, the telegram which one character is supposed to hand another in a crucial scene. If such "small" matters are let go till the last night, they are easily overlooked in the rush of caring for other things.

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*The diagram may be a very simple drawing but should show the location of doors, windows, exits, and all properties (tables, chairs, etc.).

While setting-up rehearsals are going on, the properties should be assembled and the stage sets prepared. The ideal is to have all stage sets ready for the first complete rehearsals. If, however, rehearsals cannot be held where the play is to be presented, plans for the sets should be so complete that the stage-manager can improvise a duplicate set with all the essential features. To do this he must know definitely the size of the stage so that he can block it out in the place used for rehearsal with chairs, benches, tables, etc. Then using his diagram he should fill in *accurately* the exits and entrances, furniture, etc. so that when the cast actually get on the stage with the complete set they will find the distances they have to walk and the placement of furniture familiar.

For dress rehearsals all properties for both stage and actors must be at hand and arranged systematically. Properties needed in the second act must not be piled behind properties for the third. If the telephone needed for act two is hidden away behind the porch furniture wanted for act three, much waste of time and needless commotion is caused.

Not only should things be arranged systematically at the beginning, but care must be taken in changing sets not to bury properties needed for later acts beneath the discarded properties of act one. A good plan is to have all the needed properties stacked in order on one side of the stage at the beginning of the evening and to move all sets, systematically, from that side to the other throughout the play.

Accuracy is of the utmost importance. Having once decided on the size of the set and the placement of the furniture, the stage-manager must make sure it is placed just that way for each rehearsal. If at one rehearsal the pieces of furniture (and hence the characters) are crowded together and at the next are widely separated, it will be almost impossible for inexperienced players to acquire any feeling of ease on the stage, especially in such scenes as waiting on table or serving tea. Ease is hard enough to secure at best, and all helps to obtaining it should be used.

SCENERY

In preparing scenery make use to the fullest extent of your local talent. Get in people who are interested in such matters to do the painting required, the needed carpentry, or to plan the lighting arrangements.

For a group which plans to do work from year to year there are a number of pieces of property which it may be wise to own:

1. A small low bench.
2. A set of steps, 4, 5, or 6 steps high and about four feet wide, with steps deep enough to be ascended and descended easily.
3. Two light rectangular wooden frames to be used as window frames. The sash divisions can be represented by adhesive or friction tape, and no glass will be needed.
4. A small platform, dimensions depending upon the size of the stage. It should be about the height of an ordinary step, and might be made to cover about one-third or less of the width of the stage and not more than one-quarter of its depth. Such a platform has various uses; it may, for example, be placed in front of the rear exit to give a character entering or leaving commanding elevation so that he may be seen and heard better from all parts of the hall.
5. One, two, or three arches are invaluable. Doors can be placed within them; they can be used by themselves for alcoves or rear exits; and they can be converted into long picturesque windows by the use of tape as with the frames in 3 above. Wooden frames covered with canvas and painted make the best type.

N.B.—If curtains, not flats, are used, arches will not be needed. The curtains can be draped with the same effect.

Box Sets. A really satisfactory box set is expensive and the cheap ones are apt to be unwieldy and gaudily painted. With such a set, furthermore, but little variety is possible in stage settings. A very satisfactory substitute for the expensive scenery can be made by covering wooden frames made on the pattern of draft screens with wall paper or some painted material. Frames so prepared are known as "flats".

To prepare a set of these, make the frames 7 to 8 feet high, and each frame 2½ to 3 feet wide (depending on the size of your stage). Hinge them together in sections of twos and threes. Small projecting blocks of wood should be fastened to the backs of the frames at the exterior edge of each section so that the separate sections of flats can be fastened with ropes where they come together and awkward gaps avoided. The frames may be covered with any one of the following materials: light-weight canvas, (the most expensive but most durable covering), factory cotton, burlap, duck. The covering should be painted in some soft shade (such as light blue, light grey, or a very light tan) which will blend easily with other colors which may be on the stage. In setting up flats prop them from behind or nail them to the stage.

A complete "set" of this description can be made very inexpensively, and once painted in a neutral color can be used repeatedly. In combination with a good back drop such a set of flats will make a most attractive exterior setting, and arranged to form rooms of different sizes and shapes it will give endless variety for interiors.

Curtains. Good curtains are better than poor scenery, and are being very much used by Little Theatre organizations. If you are furnishing a community hall, consider a complete set of curtains in preference to the old-fashioned box set and canvas fire curtain. Such sets made of unbleached cotton or outing flannel and including both a front curtain on pulleys and a semi-circular set of curtains for back scenery would cost approximately $250 to $300, or possibly less, depending on the size of the stage. Costs can be reduced by buying the material and making and dyeing the curtains locally. If this is done a couple extra "half-lengths" should be procured to be used for the formation of doors and windows.

Back Drop. The back drop is whatever scenery shows at the very back of the stage, as seen by the audience through doors or windows in the set. Something of this nature is essential for every good production to avoid having the doors and windows open out on stacked properties or non-painted back walls. The best type of back drop is one of painted canvas, and costs approximately $15 finished ready for painting and hanging. It can be painted on both sides. A good plan is to make one side sky blue and to have some sort of woodland set painted on the other. The best blue is just a shade darker than the clear blue of the summer sky, because that shade will reflect red, blue or purple light well. (See under lighting). If such a drop cannot be afforded a good blue background can be made by painting the back wall of the stage—if permission to do so can be obtained. It should be painted to a height of ten, twelve or fourteen feet, depending on the size of the stage.

MAKE-UP

If no one with experience is available the man doing the art work for the stage may very well try his hand at make-up. A man who is fond of drawing frequently finds himself quite good at make-up even if he has never done any before.

Use too little rather than too much. Avoid cumbersome wigs, mustaches, etc. Don't depend on them to create the illusion of the part. Powdering the natural hair is preferable to a wig, and a mustache put on with chalk of the proper colour is preferable to a hair one fastened on with adhesive or gum. (Chalk never slips!)

Never wear your own clothes. If you do, it will be much harder to lose your own personality and to assume that of the character you are acting.

Use coloured powders rather than grease paint, because the latter is shiny and if the hall should be unusually hot the shine will become very obvious. Tooth-picks should be used for lining eyes and for making facial wrinkles; brushes and chalks leave too broad lines.

Make-up is primarily dependent on proper casting. For example, almost never cast a young person for an aged part. If it must be done, use someone with more than average maturity for his years, and excessive make-up will not then be needed.

A small box of make-up is easily obtainable, and is ample. Such a box may be ordered through many drug stores, or supplies may be obtained from any of the regular theatrical supply companies.

LIGHTING

One of the great advantages of the legitimate stage over the movies is in the variety of colour and lighting effects that can be obtained. Yet this is a matter given very little consideration in most rural dramatics. No one thinks of lighting possibilities. Whatever lights there are are turned on and left without any change throughout the whole performance.

This is a big mistake. In any hall that is wired for electricity proper lighting will give most simply and inexpensively effective atmosphere and variety. The blue light of night can be created by blue light thrown on a blue curtain at the rear (the back drop). Lovely shadows can be contrived by the placement of side lights or flood lights (explained below). Lanterns, candles, oil lamps, and the ruddy glow of firelight can all be used with great effectiveness. Table lamps and floor lamps with coloured shades add much in the way of softness of atmosphere to an interior scene. Even the stage that is not equipped with electricity can arrange to use many of these aids to atmosphere.

Extensions can always be plugged in to the extreme left and the extreme right of footlights or over-head lights (commonly called "borders"). Such extensions may be used to connect up floor lamps, fireplaces and flood lights.

A flood light is a group of high-powered electric light bulbs placed in front of a polished reflector which floods the light on any part of the stage desired. A small one can be made by running an extension through the bottom of a shiny new tin pan, or polished aluminum pan, to a three-way socket and fitting it with very high powered bulbs. A sheet of tin bent to form a reflector is better than a pan. To make a more powerful light more sockets and bulbs can be used. Such a flood light can be set on a stand or small table at the side or back of the stage, and is very effective for securing sunset effects behind windows and doors, or the right amount of light on a picturesque character seated on one side of the stage.

Gelatine papers are invaluable for use in connection with floods and may be had in various colours for ten cents each from any stage supply company. The home-made flood can easily be equipped with a wooden frame for holding a gelatine paper in place in front of the bulbs, and thus the flood is made available for coloured lights. Among the simplest and most useful of these colour effects are the rose for sunrise or sunset and the blue to be thrown on a blue back drop for night light.

Aim to have bulbs of at least three different colours to equip your foot lights and "borders". Too many stages use nothing but the ordinary clear white bulbs and the effect is a glaring white light that reveals all the blemishes in the make-up and tires the eyes of the spectators. In order to avoid this, use red, white and blue in rotation across the footlights and borders. Red bulbs are not expensive. Blue glass is very expensive, but ordinary white bulbs can be dipped in a blue gelatine mixture quite inexpensively.

The amount of light on the stage can be varied by using all the available lights or by eliminating some through the use of switches or by unscrewing a certain number of bulbs. For exterior evening scenes and for interiors depicting poverty, low lights are essential. Don't expect the audience to believe it is midnight in a dark forest if you have a blaze of white light on the stage. To get the effect required for night scenes and others where dim lights may give the needed atmosphere, experiment in dress rehearsals with a stage lighted only with blue lights. If this is too dim add a few reds at strategic points, and on rare occasions a white. If the stage-manager has an eye for colour he is apt to find this the most interesting part of his work.

VII. PLAY CONTESTS

Various plans may be followed in arranging to put on plays for contests between clubs. All the clubs may be asked to work up the same play. This may, in some cases, make it easier for the judges, but it is apt to be monotonous for the audience and to result in reduced financial returns. Moreover, it is likely to prove most unfair to individual clubs as one community will possess players who fit into the parts of the chosen play very easily, while another will have no one at all suitable for some essential part. On the whole there is little to be said in favour of this plan except that it is possibly the simplest for a county executive to operate.

A group of several plays of approximately the same degree of difficulty may be chosen and each club allowed to select its own. This gives the local director some chance to choose a play which may best suit the local players. The variety in plays, furthermore, means greater interest on the part of audiences and judges.

Perhaps the best plan of all is to lay down certain conditions that the play must fulfill (for example, requirements as to length, number of scenes, and the amount of royalty permissable) and then allow each group to select its own play. The sole responsibility for choosing a play suited to the ability of director and players then rests upon the competing group, so that this is, in reality, the fairest method of competition. Some might expect such a system to make the judging of the plays more difficult, but anyone really competent to judge will have no greater difficulty in deciding which play is best presented than in the more restricted form of contest.

VIII. PLAY SUGGESTIONS

Inexpensive Programs of One-Act Plays

Below is a list of twelve programs which may be prepared using one-act plays. With fifteen minutes of music between the plays any one of these programs would make a satisfactory evening's entertainment. Six cost only $10. each for royalties and the other six only $15. These and similar programs of one-act plays will provide entertainment of much higher quality than can be found in the usual $10. or $15. royalty plays of three acts. It must always be remembered in planning programs that the plays must be selected to suit local conditions. The lists given here are suggestions only.

$10 Programs

1.	Neighbours.	Zona Gale	($10.00)
	(Royalty remitted if certain conditions are complied with.)		
	Miss Civilization.	R. H. Davis	(No Royalty)
2.	Spreading the News.	Lady Gregory	($5.00)
	The Bathroom Door	Gertrude E. Jennings	($5.00)
3.	The Weather Breeder.	Merrill Denison	($10.00)
	The Kleptomaniac.	M. Cameron	(No Royalty)
4.	Thank You Doctor.	G. Emery	($10.00)
	The Mirror.	K. Roof	(No Royalty)
5.	The Workhouse Ward.	Lady Gregory	($5.00)
	Martha's Mourning.	P. Hoffman	($5.00)
6.	A Little Fowl Play.	H. Owen	($5.00)
	Joint Owners In Spain.	A. Brown	($5.00)

$15 Programs

1.	Why the Chimes Rang.	E. McFadden	($10.00)
	The Travelling Man.	Lady Gregory	($5.00)
	Note: These would make a suitable program for the Christmas season.		
2.	Brothers in Arms.	Merrill Denison	(10.00)
	Moonshine.	A. Hopkins	($5.00)
3.	Thursday Evening.	Christopher Morley	($10.00)
	A Marriage Has Been Arranged.	A. Sutro	($5.00)
4.	The Florist Shop.	W. Hawkridge	($10.00)
	Lonesome Like.	H. Brighouse	($5.00)
5.	The Host.	F. Molnar	($5.00)
	Wurzel Flummery.	A. A. Milne	($10.00)
6.	Suppressed Desires.	S. Glaspell	($15.00)
	Sauce for the Goslings.	E. Warren	(No Royalty)

100 PLAYS SELECTED FOR RURAL PRODUCTION

A. 50 LONGER PLAYS

No Royalty.

Cricket on the Hearth	(3 acts)	Dickens
The Christmas Carol	(1 hour, 2 acts)	Dickens
The Imaginary Invalid	(3 acts)	Molière
Ralph Roister Doister	(5 acts)	N. Udall
Rip Van Winkle	(2 hours, 2 acts)	Charles Burke
The School for Scandal	(5 acts)	Sheridan
She Stoops to Conquer.	(5 acts)	Goldsmith

Royalty Under $25.

The Man Who Married a Dumb Wife	(2 acts)	A. France	($15.)
Monsieur Beaucaire	(3 acts)	B. Tarkington	($10.)
Dr. Jekyll and Mr. Hyde	(4 acts)	L. Forepaugh & G. Fish	($10.)
The Monkey's Paw	(1 hour, 1 act)	W. W. Jacobs	($10.)

Royalty $25. (All full-length plays costing about 75 cents a copy.)

Peg O' My Heart	J. Hartley Manners
A Pair of Sixes	E. Peple
Dulcy	G. Kaufman and M. Connelly
I'll Leave It To You	Noel Coward
You Never Can Tell	G. B. Shaw
Charley's Aunt	Brandon Thomas
The Charm School	A. Miller and R. Milton
Come Out of the Kitchen	A. Miller
Daddy Long Legs	Jean Webster
The Boomerang	W. Smith and V. Mapes.
Nothing But The Truth	J. Montgomery
Pollyanna	C. Cushing
The Fortune Hunter	W. Smith
Green Stockings	A. Mason
Grumpy	H. Hodges and W. Percyval
The Hottentot	D. Mapes
The Intimate Strangers	B. Tarkington
Little Women	L. Alcott
Merton of the Movies	G. Kaufman
Old Lady 31	R. Crothers
Minick	G. Kaufman and Edna Ferber
The Mollusc	H. Davies
Penrod	B. Tarkington
The Poor Little Rich Girl	E. Gates
The Private Secretary	C. Hawtrey
The Rejuvenation of Aunt Mary	A. Warner
Seventeen	B. Tarkington
The Thirteenth Chair	B. Veiller
Three Live Ghosts	F. Isham and M. Marcin
The Truth	Clyde Fitch
The Enchanted Cottage	A. W. Pinero
Ice-Bound	O. Davis
Milestones	Arnold Bennett
Mama's Affair	R. Butler
Are You a Mason?	Leo Ditrichstein
The Torch Bearers	George Kelly
Mrs. Wiggs of the Cabbage Patch	A. C. Flexner

B. 50 ONE-ACT PLAYS

No Royalty

The Ghost Story	B. Tarkington	.50
The Trysting Place	B. Tarkington	.50
The Mirror	K. Roof	.30
Miss Civilization	R. Harding Davis	.35
Pierrot of the Minute	E. Dowson	.35
The Kleptomaniac	M. Cameron	.30
The Neighbors	Z. Gale	.50
	(No royalty only if certain conditions are complied with.)	
Sauce for the Goslings	E. Warren	.30

$5.00 Royalty

The Host	F. Molnar (One-Act Plays for Stage and Study, Second Series.)	Volume $3.15
Miss Tassey	E. Baker	.50
Moonshine	A. Hopkins	.35
The Bathroom Door	G. E. Jennings	.30
Spreading the News	Lady Gregory	.50
The Rising of the Moon	Lady Gregory	.50
The Workhouse Ward	Lady Gregory	.50
The Travelling Man	Lady Gregory	.50
Martha's Mourning	P. Hoffman	.35
Lonesome Like	H. Brighouse	.50
A Marriage Has Been Arranged	A. Sutro	.30
Facing Fact	A. Gerstenberg— In manuscript which can be obtained on deposit of $5.00	
Joint Owners in Spain	A. Brown	.35
Where But in America	O. Wolff	.35

$10.00 Royalty

Thank You Doctor	G. Emery	.50
Wurzel Flummery	A. A. Milne	.35
The Boy Comes Home	A. A. Milne	.30
Trifles	S. Glaspell	.50
Thursday Evening	C. Morley	.50
Good Theatre	C. Morley	.50
Knave of Hearts	L. Saunders	.50
Sham	F. Tompkins	.50
A Fan and Two Candlesticks	M. Macmillan	.50
The Florist Shop	W. Hawkridge	.50
The Neighbors	Z. Gale	.50
'Op-o'-Me Thumb	R. Pryce and F. Fenn	.30
The Slave With Two Faces	M. C. Davies	.35
The Pot Boiler	A. Gerstenberg (Ten One-Act Plays)	Volume $2.10
Fourteen	A. Gerstenberg (Ten One-Act Plays)	Volume $2.10
Overtones	A. Gerstenberg (Ten One-Act Plays)	Volume $2.10
The Grill	Geo. Johnston (A New Anthology of Ten One-Act Plays)	Volume $2.65
Two Crooks and a Lady	E. Pillot (Harvard 47 Workshop Plays, Vol. I)	Volume $1.35
Why the Chimes Rang	E. McFadden	.35
Weather Breeder	M. Denison (The Unheroic North)	Volume $1.50
Brothers in Arms	M. Denison (The Unheroic North)	Volume $1.50
Man's World	F. Jacob (One-Third of a Bill)	Volume $1.50
The Lost Silk Hat	Lord Dunsany	.50
The Golden Doom	Lord Dunsany	.50
A Night at an Inn	Lord Dunsany	.50
The Glittering Gate	Lord Dunsany	.50
Will o' the Wisp	D. Halman (Set the Stage for Eight)	Volume $1.60
The Philosopher of Butterbiggins	H. Chapin	.30

Miscellaneous Royalties

The Maker of Dreams	O. Down	.50	$ 8.00
Suppressed Desires	S. Glaspell	.50	15.00
The Trap	A. Gerstenberg In manuscript, Deposit of $5.00		

Every care has been taken to make the information in the lists given above accurate, but it cannot be guaranteed. Royalties change from time to time; hence the publishers should always be consulted before the production of any play is planned.

Single copies of the plays listed may be borrowed from the Package Library, Ontario Agricultural College, Guelph. Not more than two long plays or three one-acts should be asked for at one time.

The Package Library has prepared a list of plays in which may be found many more of the non-royalty or low royalty plays. Copies of this list may be obtained free.

IX. SOURCES OF MATERIAL

Catalogues and other information may be obtained from the publishers of plays and from the theatrical supply houses. A list of the chief publishers of plays and operettas and of some of the leading companies supplying costumes, curtains, lighting equipment, scenery and general stage equipment may be obtained free by writing to the Package Library of the Ontario Agricultural College, Guelph, Ont.

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BULLETIN 349] [DECEMBER, 1929

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE
GUELPH

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Grain Smuts

By

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Department of Botany

INTRODUCTION

The objects of this bulletin are to make available to the farmers of Ontario the knowledge scientific workers have acquired concerning the nature of grain smuts and to give them concise information about the best methods of preventing grain smuts.

With these objects in view, the writers have endeavoured to discuss the subject in clear, simple, non-technical language, so that all who read this bulletin may readily understand it. It is hoped that this bulletin may help to spread more widely the information which will aid farmers in preventing losses from smuts.

The methods of preventing grain smuts recommended in this bulletin are those which experiments extending over a period of ten years have proved to be safe and effective. They cost but little and are easily and quickly applied.

LOSSES DUE TO GRAIN SMUTS

It is extremely difficult, if not impossible, to estimate the financial loss caused by these diseases. The following rough estimate of the loss has been made by considering the value of the different grain crops grown in Ontario each year and the estimated annual average per cent. that the yield of the different crops is reduced by smut.

OATS.

Market value of the yearly crop about	$50,000,000
Estimated annual loss due to oat smut 5 per cent	$2,500,000

WHEAT

Market value of the yearly crop about	$26,000,000
Estimated average annual loss due to smuts 5 per cent	$1,300,000

BARLEY

Market value of the yearly crop about	$17,000,000
Estimated annual loss due to smuts 4 per cent. of crop	$680,000

Corn (grown for husking)

Market value of the yearly crop about	$7,000,000
Estimated average annual loss to corn 2 per cent	$140,000
Total yearly financial loss	$4,620,000

These figures are but approximate, but they serve to impress the fact that the annual loss caused by grain smuts is very much larger than is generally realized. This financial loss to farmers in Ontario is to a large extent a needless one, as nearly all grain smuts can be prevented almost entirely by proper treatment of the seed.

The Cause of Grain Smuts

The grain smuts are fungus diseases, that is, they are caused by minute, colourless plants called fungi which have lost the power of manufacturing their own food and have become thieves or parasites stealing their foods from other plants and in so doing injure them in various ways, thus causing what are known as fungus diseases. The bodies of the fungi which cause smuts of grain consist of fine, delicate threads or tubes (hyphae) which are so exceedingly small that they can be seen only with the aid of a microscope. These hyphae or threads live between the cells of the grain plant and obtain their nourishment from them. Some of these fungus threads (hyphae) become changed into reproductive structures termed spores which serve the same purpose as the seeds of flowering plants, viz., dispersal and reproduction.

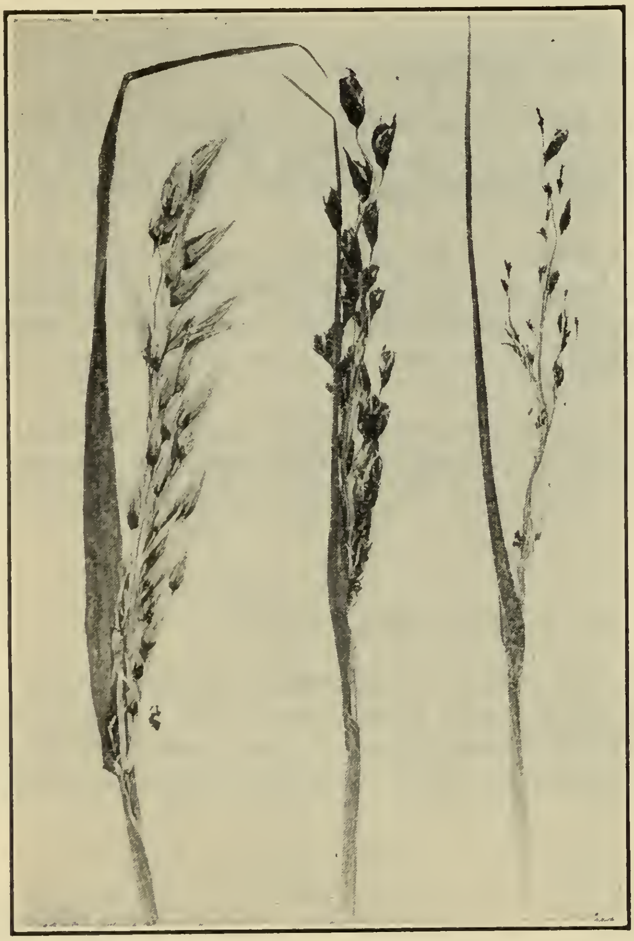

Fig. 1.—Smut of oats.
(About one-half natural size.)

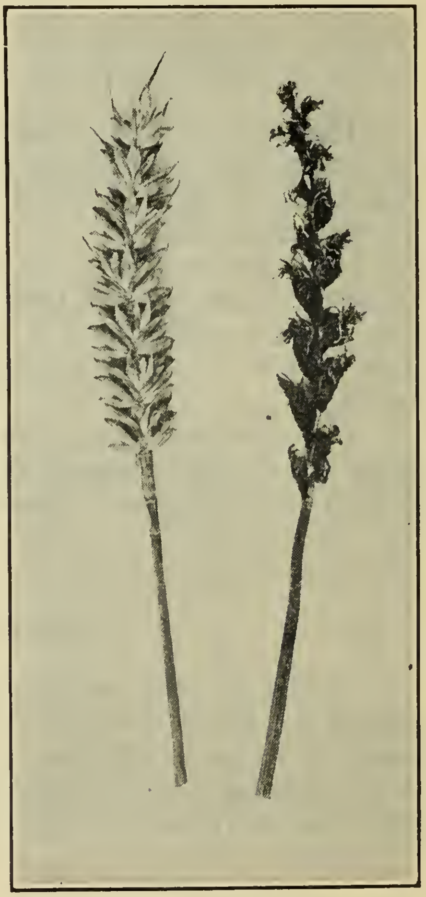

Fig. 2.—Stinking smut of wheat on left and loose smut of wheat on right.
(About one-half natural size.)

The spores of smut-producing fungi usually form in the ears or heads of the grain. The fungus threads (mycelium) attack the flowers when they begin to develop and feed upon the food being stored in the forming seeds. When this is exhausted they develop into millions of little spores. These compose the black smut masses so familiar to every farmer. These spores are exceedingly small. Some idea of their size may be had by considering the fact that each smutted wheat grain contains from two to three million spores.

The spores of smut fungi are scattered by the wind or by the threshing or handling of the grain in the case of some of the smuts. Each spore, if placed under proper conditions, is capable of reproducing its kind, finally causing again that particular smut peculiar to the parent fungus.

OAT SMUTS

Loose Smut of Oats is the commonest and most troublesome grain smut in Ontario.

Symptoms.—Loose Smut is noticed in the fields just as soon as the oats begin to head. It destroys the kernels, hull and chaff, changing them to a dark brown powder resembling soot, so that the whole head becomes a mass of smut. This smut mass is composed of millions of spores which are frequently blown away by the wind, leaving only the naked branches of the inflorescence (Fig. 1).

Cause.—Loose Smut is caused by the fungus *Ustilago avenae* (Pers.) Jensen. Until very recently it was thought that this fungus was carried over as spores on the kernel of the oat inside the hull. *Recent investigations indicate, however, that this fungus is carried over as the dormant fungus threads (mycelium) in the outer coat (pericarp) of the kernel. From a practical standpoint the important point in the life history of this organism is that it is carried over near the surface of the kernel where it can be reached and destroyed by a seed disinfectant.

Covered Smut of Oats caused by the fungus *Ustilago laevis* (K. & S.) Mag., is also present in Ontario, but in so much as the treatment for the two smuts is the same from the standpoint of a practical man they may be considered as one disease.

Prevention.—Oat smuts can be prevented by the formalin spray and the formalin sprinkle methods described on pages 11, 12 and 13 of the bulletin.

N.B.—No formalin treatment can be used safely with hulless oats. Smut in hulless oats can be prevented without injury to the germination of the seed by treating with copper carbonate dust.

WHEAT SMUTS

There are two common smuts of wheat in Ontario—Stinking smut or Bunt and Loose smut. It is very important that farmers should learn to distinguish between these two kinds, as stinking smut or bunt can be prevented by treating the seed with copper carbonate dust or formalin, while such treatment is of no use whatever in preventing loose smut. A little study will enable even a casual observer to distinguish between these two diseases.

Stinking Smut or Bunt

This is the more objectionable smut of wheat. A very small quantity of this smut renders wheat unfit for milling purposes. In some years it is far too prevalent in Ontario. This is owing to the fact that too many farmers fail to treat their seed.

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*Gage, G. R. Cornell Univ. Agr. Exp. Sta. Mem. 109.

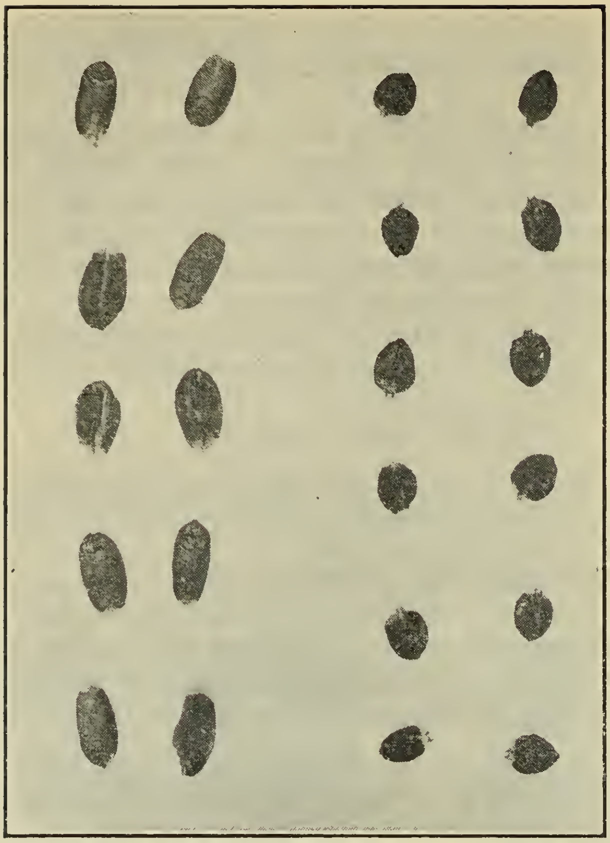

FIG. 3.—Sound grains on left; bunted grains on right. (About one-half natural size.)

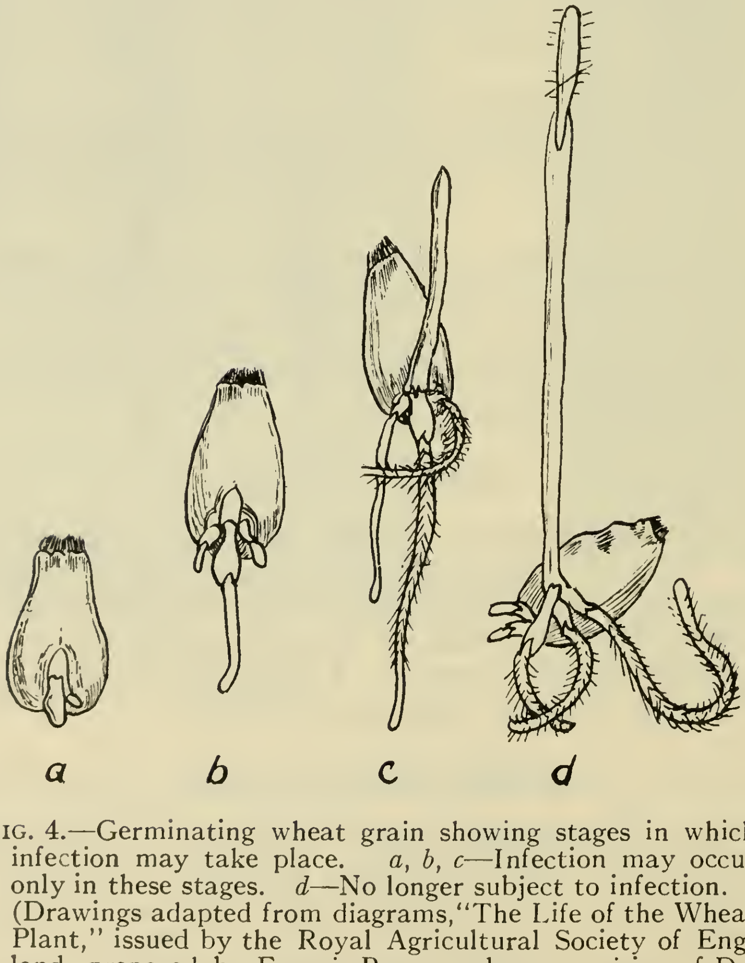

FIG. 4.—Germinating wheat grain showing stages in which infection may take place. *a, b, c*—Infection may occur only in these stages. *d*—No longer subject to infection. (Drawings adapted from diagrams, "The Life of the Wheat Plant," issued by the Royal Agricultural Society of England, prepared by Francis Bauer under supervision of Dr. Wm. Carruthers, F. R. S.).

SYMPTOMS.—This smut cannot be detected in the fields until the ears begin to fill. The smutted ears are darker green and remain green longer than the healthy ones. Later the affected ears usually stand up stiff and erect and the chaff is somewhat bleached and more or less distended (Fig. 2). The grains only are directly affected. They are short, plump, light in weight, somewhat discolored and filled with a brownish black, somewhat oily powder which has an odour like decaying fish. When a bunted grain "smut ball" is broken the disagreeable odour of the powder within is very pronounced (Fig. 3). These "smut balls" are broken and the powder scattered in threshing and handling the grain. Hence this smut even in small quantities can be detected by the odour it imparts to the wheat.

CAUSE.—Stinking smut or Bunt of wheat is caused by two closely related but distinct smut fungi—a smooth spored species, *Tilletia laevis,* Kühn, and a rough spored species, *Tilletia tritici* (Beij.). Wint. The life histories of these two fungi are practically the same. The dark, ill-smelling powder in the diseased grains consists of numerous spores. It has been estimated that one "smut ball" may contain between 2 and 3 million spores. The "smut balls" are broken during the threshing and handling of the wheat and the spores scattered among the sound grains, to which they adhere. The fungus is thus carried over as spores on the seed. When the seed is sown and germinates, the spores also germinate and produce delicate threads which enter the very young seedling plants. The infection of the wheat plant can take place apparently only during the short period from the beginning of germination to the time when the first green leaf pushes through the colourless sheath in which it is enclosed (See fig. 4). This is the only time that the fungus can gain entrance to the wheat plant. The fungus lives and grows inside the wheat plant following the growing point up the stem and when the ears begin to form enters the young ovaries and feeds on the starches, etc., being stored in them. The fungus threads which fill the diseased ovaries finally divide up into countless spores which form the dark-coloured powder which fills the bunted grains.

The temperature at seeding time has a marked influence on the amount of infection that takes place. Results of scientific investigation show that wheat is not infected at low temperatures, but as the temperature of the soil is raised the number of plants becoming affected increases until at a temperature of 41 to 50 degrees F. the maximum infection takes place. A further increase in temperature causes a decrease in the amount of infection until at 70 degrees F. wheat completely escapes attack.*

PREVENTION.—Stinking smut or Bunt can be prevented by treating the seed with copper carbonate dust or with formalin.

Our experiments have shown that copper carbonate dust controls Stinking smut of wheat without lessening germination and is at the same time quickly and easily applied. (See directions, pages 13, 14 and 15.)

Sprinkling with a formalin solution (1 pint to 40 gallons of water) has also been found effective, but in some seasons has reduced the germination of the seed to a noticeable extent. (See directions, pages 12 and 13.)

Seed wheat which is to be treated for smut should first be thoroughly cleaned. This can be done with a good fanning mill. The cleaning of the wheat is especially important when formalin is used, for if the "smut balls" are not removed the formalin treatment will not be entirely effective.

LOOSE SMUT OF WHEAT

This smut is more common and does more damage to wheat in Ontario than is generally realized by the grain grower. This is owing to the fact that most of this smut is blown away long before harvest time and thus may be overlooked by the grower unless he happens to be inspecting his fields about the time the wheat is coming into ear.

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*Based on Woodman, H. M., and H. B. Humphrey—U.S. Dept. of Agric. Bull. 1239—1924.

Symptoms.—Loose smut is seen in the field just as soon as the wheat begins to ear out. It destroys both the grains and the chaff, changing them to a black powder. The whole head thus becomes a black smut mass. These smut masses are broken up and blown away by the wind, the only remaining evidence at harvest time being the naked central axis of the ear (Fig. 5).

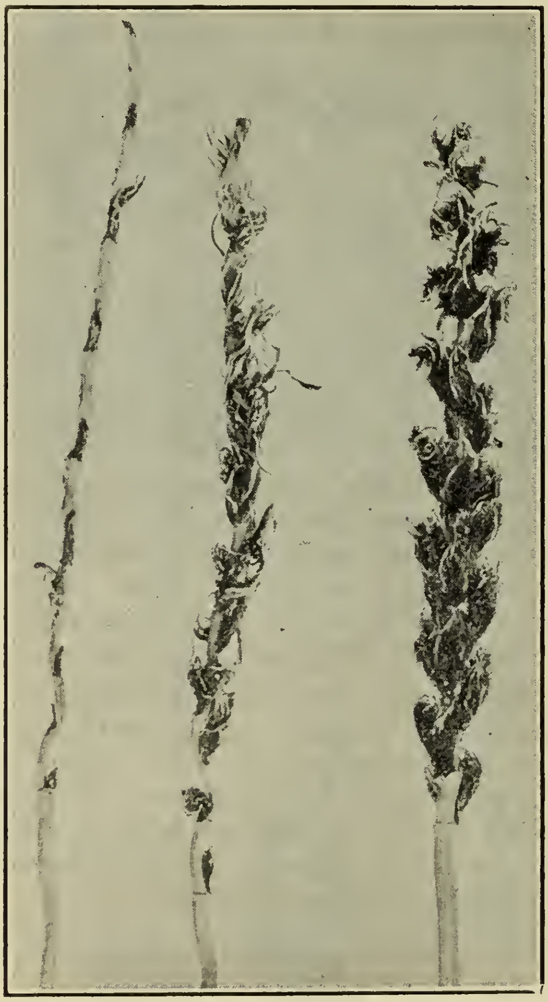

Fig. 5.—Loose smut of wheat. (About natural size.)

Cause.—This smut is caused by the fungus *Ustilago tritici* (Pers.) Rostr. The smut masses consist of millions of spores. These are scattered by the wind when the wheat is in flower. Some of these spores reach sound ears of wheat and get in between the chaff on to the flowers. The spores germinate at once and produce delicate fungus threads (germ tubes) which gain entrance to the developing grain. Once inside the grain the fungus remains dormant. The infected grains are perfectly sound and there is no way of telling them from the grains not infected except by skilful microscopic examination. The loose smut fungus is thus carried over from season to season as the dormant fungus threads (mycelium) in the seed (See fig. 6).

When the seed is sown and germinates, the fungus threads inside begin to grow and follow the growing point up the stem finally invade the ears and chaff and convert them into a mass of smut.

Treatment.—Loose smut of wheat CANNOT be prevented by treating the seed with copper carbonate dust or formalin. If possible, secure seed from a district where loose smut is not present. Such seed will produce a crop free from this smut. If this smut is very prevalent and it is impossible to secure seed from a district free from it, it may be necessary to establish a seed plot and treat the seed as directed by the hot-water treatment described on pages 16 and 17.

Summarized Comparison of Stinking Smut and Loose Smut

Loose Smut	*Stinking Smut*
1. Destroys both the grain and chaff.	1. Destroys only the grain.
2. Has no disagreeable odour.	2. Has a very disagreeable odour.
3. Spores scattered by the wind at flowering time.	3. Spores scattered in threshing and handling of grain.
4. Fungus carried over as fungus threads (mycelium) inside the seed.	4. Fungus carried over as spores on seed.
5. Cannot be prevented by treating the seed with copper carbonate dust or formalin.	5. Can be prevented by treating the seed with copper carbonate dust or formalin.

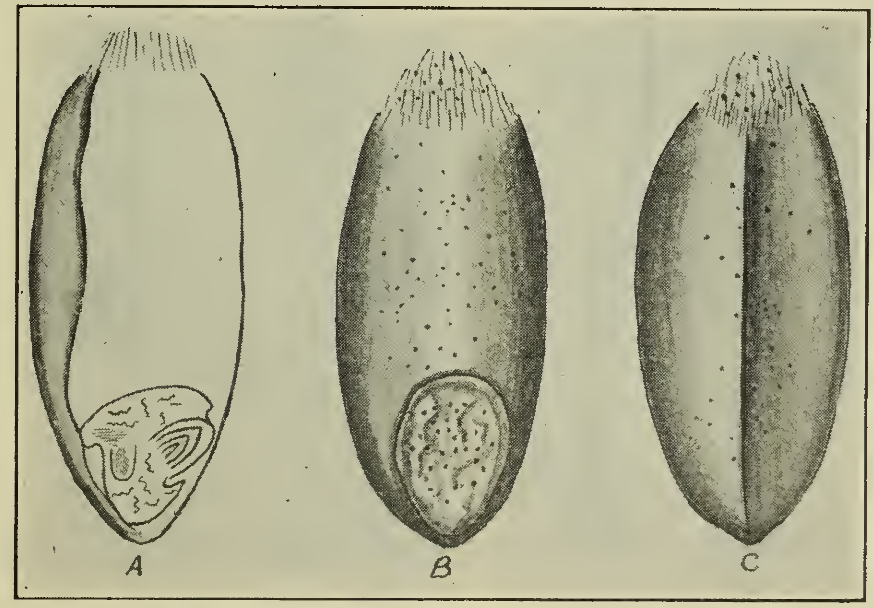

Fig. 6.—Difference in the method by which Loose smut of wheat and Stinking smut or Bunt is carried over from crop to crop.
A. Mycelium of the Loose smut fungus in the wheat germ.
B. and C. Spores of Stinking smut or Bunt on the wheat grain.

BARLEY SMUTS

There are two kinds of barley smut, viz., Loose or Naked Smut of Barley and Covered Smut of Barley. The former appears to be the more prevalent and more serious disease in Ontario. It is very important that farmers should learn to distinguish these two smuts, as the Covered Smut can be prevented by treating the seed with formalin, while such treatment cannot be relied upon to prevent Loose or Naked Smut.

Loose or Naked Smut

This is the smut which does the most damage to barley in Ontario.

SYMPTOMS.—It is very similar in appearance to Loose Smut of Wheat. It is observed in the fields just as soon as the barley begins to ear out. It converts both the chaff and the grain into a black powder resembling soot. This powder, which is in reality a mass of spores, is soon blown away by the wind, so that at harvest time there is nothing left but the naked axis of the ear. (See fig. 7.)

CAUSE.—Loose Smut of Barley is caused by the fungus *Ustilago nuda* (Jens.) Kellerman and Swingle. The life history of this organism is very similar to that of the fungus which causes Loose Smut of Wheat. The spores are scattered by the wind when the barley is in flower. Some of them reach healthy ears of barley and drift in between the chaff onto the flowers. They germinate at once and produce delicate fungus threads (germ tubes), which reach and penetrate the developing grains. Once established inside the grain, the fungus soon becomes dormant. Infected grains are perfectly sound and there is no way of telling them from grains which are not infected, except by very delicate and skilful microscopic examination. The fungus which causes Loose or Naked Smut of Barley is thus carried over mainly as dormant fungus threads (mycelium) inside the seed. On the germination of the seed the fungus threads commence to grow inside the germ and as the plant develops, follows the growing point up the stem, finally invading the flowers and chaff and converting them to a mass of smut.

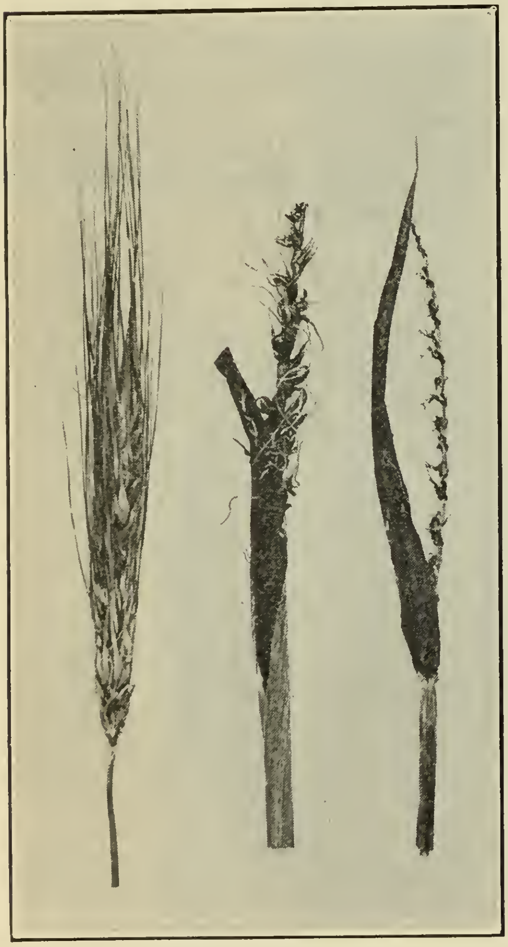

FIG. 7.—Loose or naked smut of barley. (About one-half natural size.)

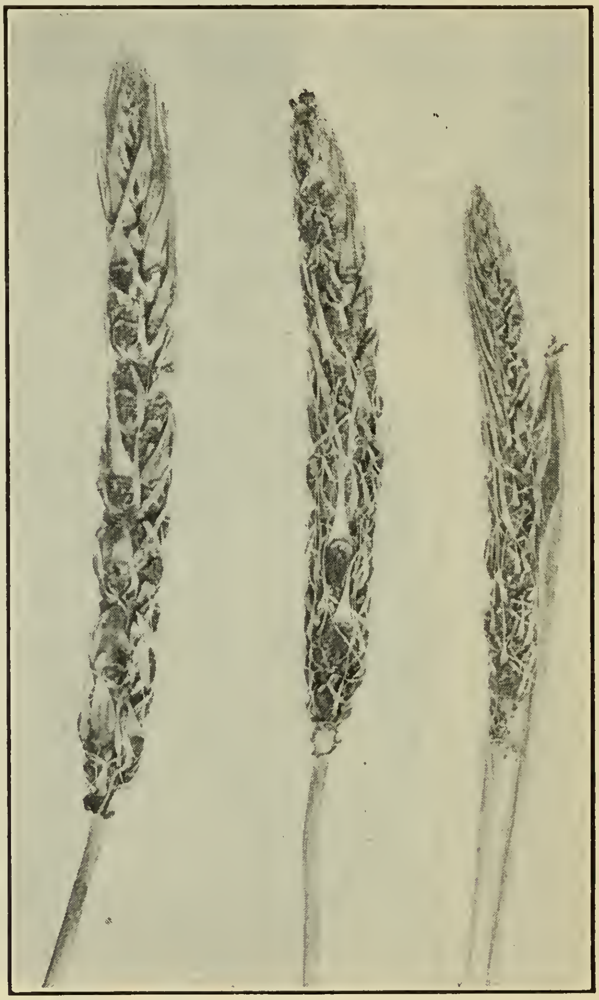

FIG. 8.—Covered smut of barley (About natural size.)

*Recent investigations indicate that the fungus which causes this disease may in some varieties of barley live over at least in part as spores on the seed.

Prevention.—The Department of Botany, during the last few years, has experimented with a large number of seed disinfectants in the hope of finding a simple, easy treatment for the prevention of this smut. None of these proved reliable, and the hot-water treatment, as recommended for Loose smut of wheat, is the only one which has been found wholly effective, and it is, therefore, recommended for Loose smut of barley (See pages 16 and 17 for directions).

Covered Smut of Barley

Symptoms.—This smut attacks the chaff and kernels, but the smut mass usually remains covered, each smutted grain (spore ball) being enclosed in a delicate, white skin. This smut is often found in the threshed grain in the form of black, irregular masses. It is sometimes difficult to distinguish the Covered from the Loose smut of barley, but the former may be recognized usually by its later appearance in the field, by the white membrane covering the smut balls and the coal-black colour of the smut mass. (See fig. 8.)

Cause.—This smut is caused by the fungus *Ustilago hordei* (Pers.) Kellerman and Swingle. The spores of this fungus may be to some extent liberated and scattered by the wind before the grain is harvested, but probably most of them are dispersed in the threshing and handling of the grain. The fungus is carried over from season to season as spores adhering to the seed. This smut can get established in the barley plants only when they are in the very young seedling stage. The life history of the fungus causing covered smut of barley is, therefore, for all practical purposes, similar to that of the organism causing stinking smut of wheat.

Prevention.—This smut can be prevented by sprinkling the seed with formalin solution (1 pint to 40 gallons of water. See directions, pages 12 and 13).

Summarized Comparison of Loose and Covered Smut of Barley

Loose	*Covered*
1. Appears earlier; begins to show as soon as the ears appear.	1. Does not show until about 2 weeks later.
2. Smut masses usually dispersed by the wind soon after they appear, leaving only the bare stalks.	2. Smut masses usually remain until harvest.
3. The smut mass has a dark brown colour. The skin around it very soon ruptures.	3. The smut mass is almost coal-black, and the white skin usually remains around it.
4. The fungus is carried over mostly as the fungus threads (mycelium) in the seed.	4. The fungus is carried over as the spores on the seed.
5. Formalin treatment cannot be relied upon to prevent this smut.	5. Formalin treatment will prevent this smut.

CORN SMUT

This smut is exceedingly common and is familiar to every farmer who grows any corn. The sugar or table corns seem to be more subject to smut than the field corns, but no commercial varieties are known that are entirely free from smut. Many farmers consider the loss due to corn smut too small to demand any particular attention, but the aggregate loss in Ontario is undoubtedly large. In the corn-growing sections of the Province this smut causes an appreciable loss to the growers nearly every year.

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*Tisdale, W. H., and B. F. Bapke—Journal Agric. Research-29: 263-284—1924.

SYMPTOMS.—Corn smut is not confined to the ears, but affects also the stalks, leaves and tassels. It produces on the parts attacked peculiar growths, usually spoken of as "boils." These "boils" are sometimes six or more inches in diameter. They are white and polished in the early stage, but become darker as they mature, and finally rupture and expose a brownish-black mass of powder consisting of millions of spores (Fig. 9).

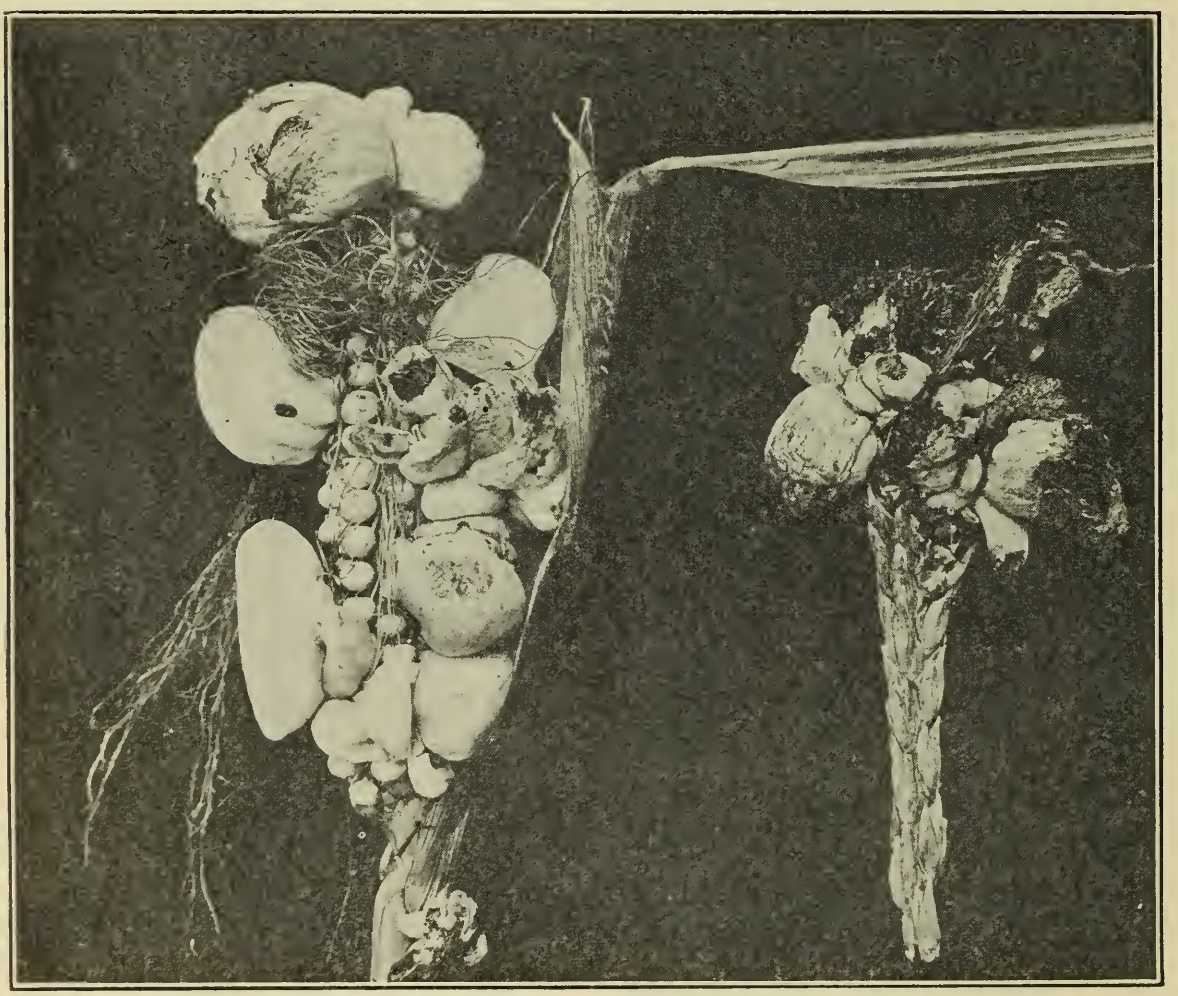

FIG. 9.—Corn smut on ear and tassel. (About one-half natural size.)

CAUSE.—This smut is caused by the fungus *Ustilago zeae* (Beckman) Unger. As soon as the "boils" mature and rupture, the spores are scattered by the wind and other agencies. These spores germinate in soil or in manure and produce great numbers of secondary spores, which may infect any of the tender growing tissues of the corn plants. Thus the smut is spread during the growing season. There may be several generations of corn smut in a season favourable for the development of the fungus which causes it. The fungus is carried over the winter as spores in the soil and in manure. These may be contaminated in various ways. The spores may be scattered by the wind or the spore masses may be left in the field or thrown on the refuse or manure pile. It is believed that the spores of this fungus not only live in the manure pile, but that they may actually grow and increase in number in warm, fermenting manure.

Prevention.—No seed treatment will prevent corn smut, as the fungus which causes it is carried over the winter as the spores in the soil and in manure. There is no way of entirely preventing corn smut. It can be much reduced, however, by the following precautions:—Avoid applying fresh manure directly to the corn crop, as it is very likely to contain live smut spores. If possible, practice a rotation of crops. The spores of this fungus will not live for many years in the soil, and those which are in the soil cannot injure any other farm crop. After three or four years, corn may be planted again with less danger, as many of the spores will have lost their vitality by this time. When only a small area of corn is grown, go over the field and cut out and burn all smutty growths as soon as they appear, as each "boil," when mature, is a source of infection to the healthy plants around it. Experiments carried out at the College have shown that when smutty corn is put in the silo most of the spores of the fungus are destoryed by the acids developed during the fermentation of the ensilage.

METHODS OF PREVENTING GRAIN SMUTS

There are a number of successful methods of treating grain to prevent smut. Those which ten years' experiments conducted by the Department of Botany have proved to be the most effective and most simple in application will be described here.

FORMALIN TREATMENTS

There are several simple and effective methods of treating seed grain with formalin. They are briefly described below. The grain should be sown as soon as possible after being treated with formalin.

FORMALIN SPRAY

This method has been tested for ten successive years by this Department. In all, some forty field trials under ordinary farm conditions have been made and over 3,200 bushels of oats treated by this method. The results have been uniformly satisfactory. In no instance has there been any appreciable injury to the grain, and the control of the smut has been almost perfect. In no case has there been more than a very small percentage of smut in any field in which treated seed was sown. While the smut in the fields sown with untreated seed for a check averaged 5.71 per cent., in some of the fields sown with untreated seed the amount of smut was as high as 15 per cent. This method is recommended for the prevention of oat smuts only in the ordinary or hulled varieties of oats. It is not recommended for hulless oats, as formalin prevents the proper germination of hulless varieties of oats.

Directions.—

Materials needed: Formalin (40 per cent. formaldehyde).
A quart sealer sprayer.
Water.
Sacks or blankets, tarpaulin, etc.
A clean floor on which to spread out the treated seed.
Shovels for mixing the grain.

Use equal quantities of formalin and water; that is, one pint of formalin to one pint of water. A quart of this solution should be applied to fifty bushels of oats. If smaller or larger quantities are treated be sure to use proportional amounts of the formalin solution. Thus 25 bushels of oats require only ½ pint of formalin mixed with ½ pint of water. A small quart sealer sprayer, like the one shown in the accompanying illustration (Figure 10), is the most convenient for applying the formalin solution to the oats. A sprinkling can is not satisfactory.

Sweep a portion of the granary or barn floor, then spray it with a little of the formalin solution. Place the oats to be treated in a pile on the floor and shovel them into another pile on the sprayed portion of the floor, and as they are being shovelled over spray them with the formalin solution.

Two men can best do the work. One man should shovel the grain while the other sprays each shovelful (See figure 11). When finished, spray the bags on both the inside and the outside and cover the pile of oats with them. Old carpets, blankets, tarpaulin, etc., may be used to cover the treated oats, but should first be sprayed the same as the bags. Leave the oats covered for four or five hours, then uncover them and they are ready to sow (Figure 12). When treating the oats by this method, open the doors so as to give plenty of ventilation and hold the sprayer close to the oats. If this is not done, the strong fumes of formalin will cause much irritation to the eyes, nose and throat. The advantages of this method over those which have been practised here before are simplicity, rapidity and ease of application. In our experiments it was found that 100 bushels of oats could be treated in 50 minutes by this method. There was no waiting for the seed to dry after treatment, no danger of its sprouting or moulding or of the grain being swollen so that it would not run freely through the seed drill.

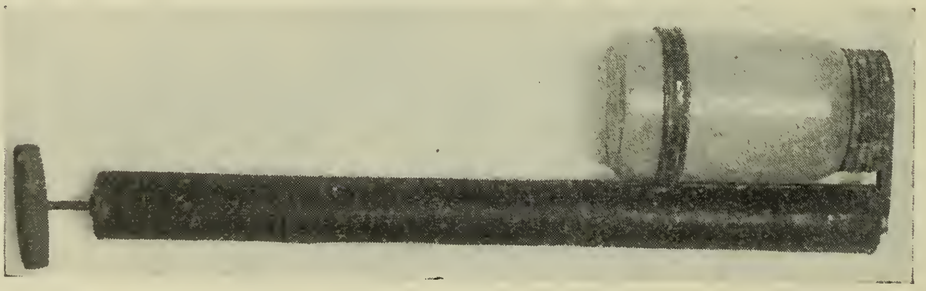

Fig. 10.—Quart sealer sprayer for the formalin spray method.

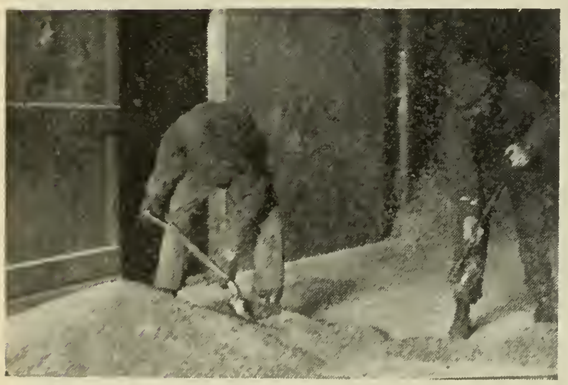

Fig. 11.—Applying the formalin spray.

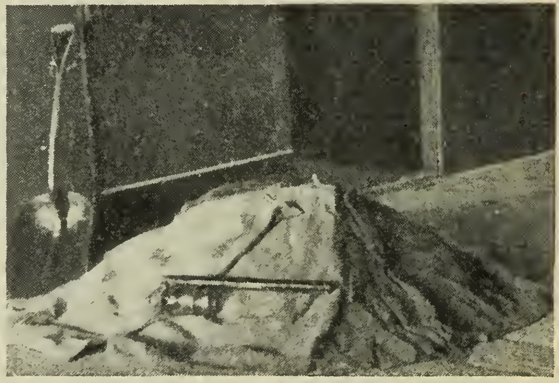

Fig. 12.—Oats covered with sacks after applying the formalin spray.

Formalin Sprinkle

This method is recommend for the prevention of Oat Smuts and Covered Smut of Barley. It can be used also for the prevention of Stinking Smut or Bunt of Wheat. It is, however, not as safe and satisfactory a treatment for this smut of wheat as is the copper carbonate dust treatment described elsewhere.

Materials needed: Formalin (40 per cent. formaldehyde).
A barrel.
Water.
Shovels for mixing the grain.
An ordinary garden sprinkling can.
A clean floor on which to spread out the treated seed.

DIRECTIONS.—Mix one pint of formalin with 40 gallons of water. Place the grain to be treated on a clean floor. Sprinkle the formalin solution over the grain, then shovel the grain into another pile, so as to mix it thoroughly, then sprinkle and shovel again. Repeat this operation until every grain is moistened by the solution. Just enough of the solution should be applied to thoroughly moisten every grain, but not enough to make the pile wet and soppy. Forty gallons of this formalin solution is sufficient to sprinkle between 50 and 60 bushels of grain, so that it takes ⅔ of a gallon or more per bushel. It is important to use proportional amounts of the formalin solution. After the grain has been thoroughly sprinkled, cover the pile with bags, sacks, blankets, etc., which have been sprinkled with or soaked in a formalin solution and leave for three or four hours. At the end of this time uncover the grain and spread it out thinly to dry. It is often advisable to shovel it over 3 or 4 times to hasten drying (See figures 13 and 14).

N.B.—No formalin treatment can be used safely with hulless oats. Smut in hulless oats can be prevented by treating the seed with copper carbonate dust (See directions below).

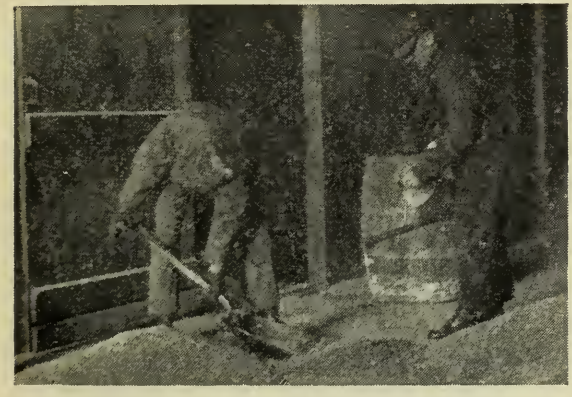

FIG. 13.—Sprinkling with a formalin solution.

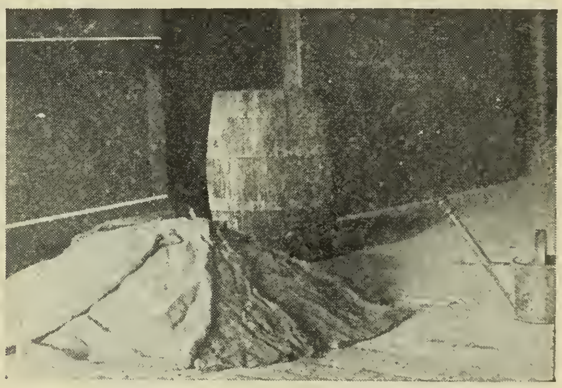

FIG. 14.—Grain covered with sacks after treatment.

COPPER CARBONATE DUST TREATMENT

This treatment is recommended for the prevention of Bunt or Stinking Smut of Wheat and smut in hulless oats. It will not control smut in grain with a hull such as ordinary oats or barley. This treatment will not prevent Loose smut of wheat.

Materials needed: Copper carbonate dust.
Dust mixing machine.
A shovel for handling the grain.

DIRECTIONS.—This dust should be applied at the rate of from 2 to 3 ounces per bushel, depending upon the amount of smut present. Smut mixing machines are now on the market for applying dust rapidly to large quantities of grain. Put the grain and copper carbonate dust into the mixing machine and rotate for 2 or 3 minutes or until every grain is thoroughly covered with dust. It is advisable to wear a dust mask or wet handkerchief over the mouth and nose while treating the grain. If a smut treating machine is not available, a home-made dust mixing machine may be made from a barrel churn or ordinary barrel, or some types of cement mixers may be used for treating the grain.

THE ADVANTAGES OF TREATING WHEAT AND HULLESS OATS WITH COPPER CARBONATE DUST

(1) It does not injure germination.
(2) Seed can be treated when convenient and stored without injury.
(3) Dusted seed can be sown at any time in dry or moist soil.

DISADVANTAGES

(1) Treated seed cannot be used for milling purposes.
(2) Treated seed must be kept dry and should not be allowed to stand in the seed drill.
(3) Any dust that collects in the seed drill should be cleaned out, as it may become caked and injure the drill.

N.B.—If the drill has not been used for a few hours, it is advisable to rock the wheels before starting to loosen the grains and gearings.

SIMPLE HOME-MADE DUSTING MACHINE

The following are the directions for making a very simple home-made dusting machine from a barrel and materials available on any farm.

The materials necessary are:—(1) A strong barrel with one head; (2) 4 short pieces of 2 x 2 pinewood; (3) 4 boards 6 inches wide by 3 feet long; (4) an old canvas; (5) a piece of rope or strap about 8 feet long; (6) 4 small wood blocks, 2 x 2 x 2, and a few nails.

Either an oil barrel or a lime-sulphur barrel or even a strong salt barrel can be used for making this machine. Remove one head of the barrel and clean it thoroughly. Next cut out a piece of 2″ x 2″ scantling of such length that it will just fit across the barrel 6″ from the bottom and nail in place. Then cut a second piece to fit just above this and fasten it at right angles to the first piece. Then cut two similar pieces to fit the other end of the barrel about 6″ from the top. Next take the four 6″ boards and cut one side to fit the curve of the barrel. These boards, after they are cut, should be firmly nailed to the cross pieces. Nail the four small blocks to the outside of the barrel about 2″ from the top. The machine now has the appearance of figure 15.

DIRECTIONS FOR USING THE MACHINE

Pour a bushel of the grain into the barrel and then add the correct amount of dust. Add a second bushel, and add more dust (Figure 16). Place a piece of canvas over the open end of the barrel and fasten it in place with a piece of rope or strap. Be sure to see that the rope is fastened just below the blocks on the outside of the barrel. Tip the barrel over on its side and roll it for 10 or 12 feet and then roll it back again. Repeat 2 or 3 times (Figure 17). Remove the canvas and empty the grain on the barn floor, so that it may be shovelled into bags (Figure 18).

With this simple machine, 60 bushels of grain may be treated in an hour. The dust will be thoroughly mixed with the grain. Furthermore, the dusted grain requires little handling and very little dust escapes, so that a gas mask or wet handkerchief over the mouth is not needed when copper carbonate dust is being used. By this method the dust is so thoroughly mixed with the grain that little inconvenience is experienced in sowing. This is especially true with hulless oats.

COPPER CARBONATE

This is a fine greenish powder. Brands containing 20 per cent. copper have been found as effective as those containing more copper. Copper carbonate

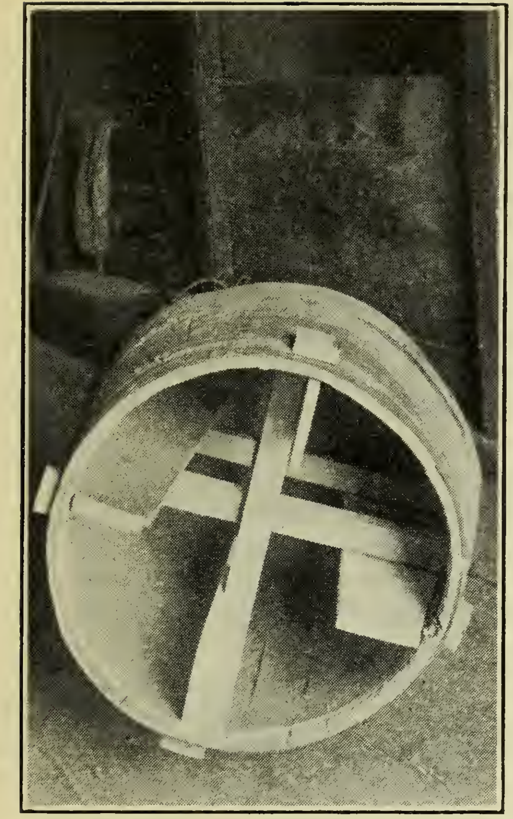

FIG. 15.—Home-made seed duster ready for use.

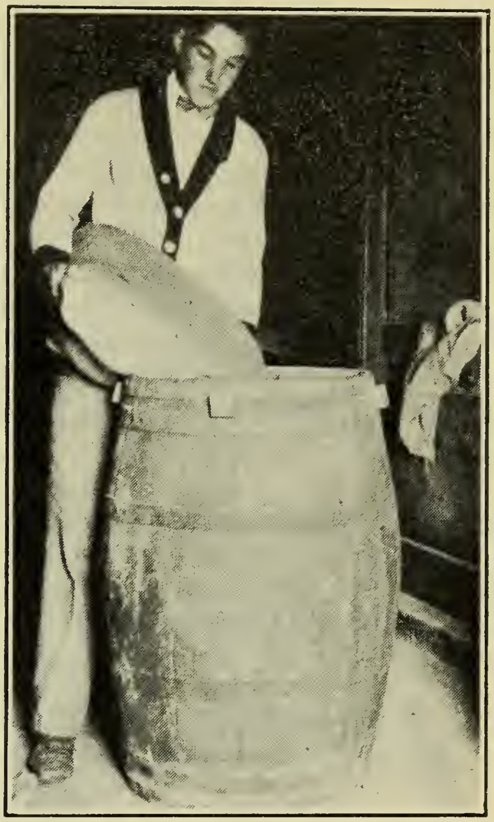

FIG. 16.—Putting grain and dust in the seed duster.

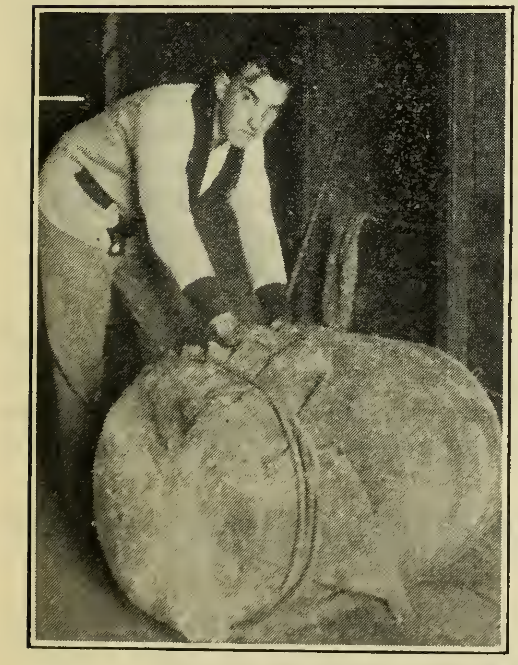

FIG. 17.—Mixing the grain and dust by rolling the barrel.

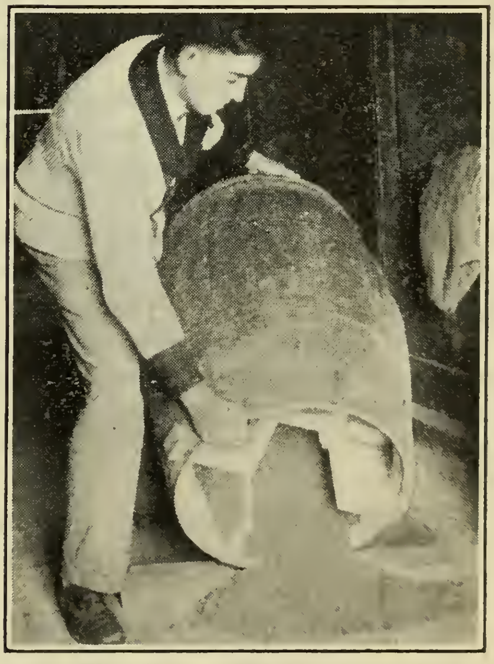

FIG. 18.—Emptying the barrel.

dust can be purchased from the local hardware stores or from any of the larger firms dealing in insecticides and fungicides. Copper carbonate dust is the safest and most effective seed disinfectant for the prevention of Bunt or Stinking Smut of Wheat and smut in hulless oats.

FORMALIN

Formalin is a clear liquid disinfectant. It is a 40 per cent. solution of Formaldehyde gas in water. It is sold under the names of Formalin and Formaldehyde. It can be purchased in drug stores and seed stores by the pound (16 ounces) or by the pint (20 ounces). It is important that the purchaser, whatever name he buys it under, secures a solution of full strength, at least not less than 38 per cent. It should be kept in a well-corked container away from frost. Formalin when diluted with water is not a dangerous poison, but a weak solution will make the eyes smart and a strong solution will harden the skin temporarily. Formalin is the safest and most efficient disinfectant for the prevention of oat smuts and Covered Smut of Barley, and it is at the same time comparatively cheap. Formalin will not prevent Loose Smut of Wheat or Loose Smut of Barley.

HOT WATER TREATMENT FOR THE PREVENTION OF LOOSE SMUT OF WHEAT AND LOOSE SMUT OF BARLEY

It also prevents other smuts to which these grains are subject.

(*a*) *Preliminary Treatment* (*soaking*)

[1]*Materials needed :*

1. One reliable thermometer; the ordinary bath-tub or room thermometer is very undesirable for this purpose, but a good dairy thermometer will serve the purpose well.
2. One large wooden barrel or any kind of metal tank or large vat.
3. A number of good strong grain bags which will allow the water to pass through rapidly.
4. Some kind of stove, boiler or fireplace to heat the water.

PROCEDURE.—1. Heat water in the boiler to almost boiling. Pour into large barrel or tank (before proceeding further, refill the boiler with water) and add slowly, with vigorous stirring, cold water until the temperature is exactly 86 degrees F. Unless the water is well stirred the correct temperature cannot be taken. Read the temperature without removing the thermometer from the water. The mercury bulb should always remain submerged when taking the reading.

2. Fill grain bags three-quarters full with the grain to be treated and tie them up loosely. Immerse into barrel with water at 86 degrees F. Move bag several times up and down, which will force out the air quickly. Take care the water covers the grain at least several inches. Allow the grain to remain in this water four hours.

NOTE.—The temperature of the water will become lower when the grain is introduced. Should it cool down too quickly—i.e., sink below 68 degrees F.—allow five hours for soaking.

Treat the grain, if possible, in a heated room to prevent the rapid sinking of the temperature. By placing the barrel or tank in a large wooden box, tightly packed with wood shavings, hay or straw all around, and covering it with a lid, the temperature remains fairly constant for four hours, once the grain has assumed the temperature of the water. One ordinary barrel will treat about one bushel of grain or a little more. Use two or three barrels or one of larger size if more grain is to be treated. The larger the barrel and the greater the volume of water, the more easily will the temperature be kept constant.

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[1] Gussow H. T. and Conners I. L. Dom. Canada Dept. Agr. Bul. 81, n. s. 1927.

(b) MAIN TREATMENT WITH HOT WATER

Additional requirements—Two large barrels or vats, each capable of holding from two to three bags of grain. A water can with a sprinkler attached.

PROCEDURE.—Into the first barrel pour a quantity of nearly boiling water and add cold water slowly until the temperature is accurately 112 degrees F. (Fill up the boiler immediately, as more water will be required in a short while.) Then take out the grain from the "soaking" barrel and place in this one. Move several times up and down and allow to remain for 15 or 20 minutes.

Meanwhile prepare the other barrel; pour in hot water as near boiling as possible, add cold water slowly, with stirring, until the temperature is exactly 129 degrees F. Then take the bags out of the second barrel (the one with the water at 112 degrees F.) and place in the barrel with water at 129 degrees F. This will cause the temperature to sink to some extent; should it sink below 122 degrees F., fill the sprinkling can with hot water and sprinkle into the barrel, but under no circumstances upon the grain or the bags containing it. When, however, the bags are well covered with water, at least four or five inches, the hot water may be safely added. To mix it with the whole contents lift the bags up and down, or move them around the barrel. The grain must remain for exactly ten minutes in this last barrel, during which time the water should be maintained evenly at a temperature from 124 degrees F.—127 degrees F. It should never sink below 122 degrees F., nor be hotter than 129 degrees F. The former will be ineffectual in killing the smut, the latter will cause unnecessary damage to the grain.*

N.B.—To dry the wet grain rapidly after treatment place it so that it will be exposed to as strong a draft of air as possible.

This hot-water treatment can be made much easier if a steam boiler is available. If a feed cooker or steam threshing engine is at hand the water in the barrels used in the main treatment can be easily raised to the desired temperature by running a pipe or strong hose from the boiler to the barrels and allowing steam to pass into the water.

Also the correct temperature can be easily maintained during treatment by allowing a little steam to pass through the water while the grain is soaking. Care must be taken that the grain does not come in contact with the steam inlet and the water must be stirred to keep the temperature uniform through the barrels.

An easy method of keeping the water well stirred is to frequently raise and lower the sacks of grain in the treating barrels. In order that this may be easily done, the sacks should not contain more than a bushel of grain. Strong burlap sacks are very useful as water readily passes through the coarse mesh and as a bushel of grain will fill such sacks less than half full the hot water will readily penetrate to all portions of the grain.

PRECAUTIONS TO BE TAKEN TO INSURE SUCCESS OF METHODS RECOMMENDED TO PREVENT GRAIN SMUTS

(1) Learn to distinguish the different grain smuts, and be sure to use the method recommended for that particular one you wish to prevent.

(2) Great care must be taken to see that treated seed is not reinfected with smut spores. Sacks, bins, implements, etc., used in handling smutted grain must also be disinfected. The sacks should be dipped in or sprayed with a strong solution of formalin and the seed drill should be cleaned and disinfected with formalin. The floor on which the grain is spread out to dry should first be sprayed or mopped with a strong formalin solution.

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*Gussow H. T. and Conners I. L. Dom. Canada Dept. Agr. Bul. 81, n. s. 1927.

(3) In sprinkling with formalin solution, apply plenty to wet every grain in the pile, but not enough to drench the grain and make it soppy.

(4) Never leave treated grain covered longer than five or six hours.

(5) Sow the seed as soon after treatment with formalin solution as possible. If the damp grain is placed in bags, in the drill or in any close place for a few hours there is a danger of the vitality of the seed becoming weakened. If wet weather prevents seeding immediately after treatment, then take precautions to see that the grain is thoroughly dry before it is bagged.

(6) If seed wheat to be treated contains bunted grains (smut balls) they should be removed before treating the grain. This is especially important when formalin is used. This can be done with a good fanning mill.

(7) On no account allow treated grain to sprout or mould or to be frozen when swollen after sprinkling with formalin.

Patent Seed Disinfectants

Many patent seed disinfectants are now on the market. Some of them are very effective, but many of them are deadly poisons and most of them are rather costly. Our experiments show that none of them prevent smut better than formalin or copper carbonate dust used as recommended in this bulletin.

Cheap Insurance

In conclusion, it may be said that seed treatment to prevent grain smuts is cheap insurance that no farmer can afford to dispense with. Take no chances; treat your seed grain every year as directed in this bulletin and then every season your grain will be free from objectionable smut.

BULLETIN 350. JANUARY 1930.

Ontario Department of Agriculture

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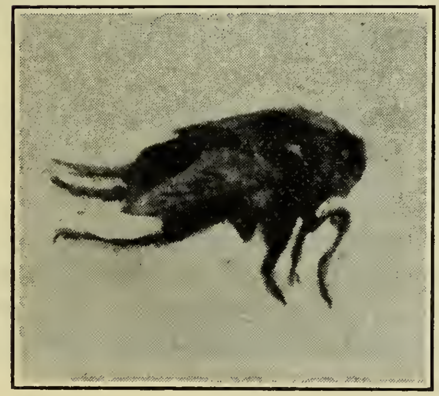
B350

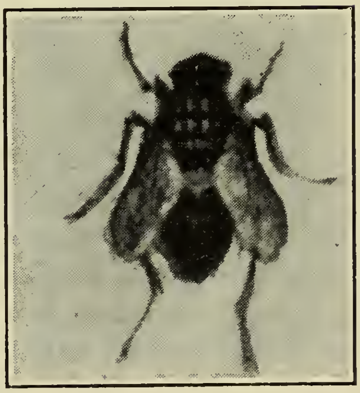
THE WARBLE FLIES

LIONEL STEVENSON, PROVINCIAL ZOOLOGIST



HYPODERMA BOVIS
(Enlarged X 2)

The Hypoderma bovis is about five-eighths of an inch long. Its tail coloring is a distinctive orange yellow. The legs are smooth and have but few hairs.



HYPODERMA LINEATUM
(Enlarged X 2)

The Hypoderma lineatum is slightly over one-half inch long. Its tail coloring, which is quite distinctive, is a reddish orange. The legs are rough and hairy.

These flies will follow the cattle into the stable and then go into the light of the windows. Look for them after the cows come in; you can catch your specimen flies there. Every stockman should know the Warble Flies when he sees them, and not confuse them with the horse flies (*Tabanids*), nor with the bot flies (*Gastrophilus*).

The two species of flies that are responsible for the so-called ''Warbley'' condition commonly found on the backs of cattle are known as Hypoderma bovis and Hypoderma lineatum. In the terms of the pasture field and farm yard they are known as the Warble Fly and the Heel Fly. The term Warble Fly is generally applied to the European importation, the *Hypoderma bovis,* and the name Heel Fly to the native fly, the *Hypoderma lineatum.* Considerable confusion exists in the minds of many stock owners, due to the two common names used for these two flies that have life histories so similar. Resulting in the Hypoderma bovis usually being called the Heel Fly, which is not correct. Many stockmen will say, ''We have always had Warbles in the backs of our cattle as long as we can remember, but it is only recently that the Heel Fly has appeared in our district.'' These cattle men apparently associate the name Heel Fly with the running of cattle when pursued by the Warble Fly (*Hypoderma bovis*). These stockmen have failed to realize that the Warbles they observed in the backs of cattle many years ago came from the eggs of the fly that we call by the common name Heel Fly. This native species deposits its eggs more in the vicinity of the heels than does the Warble Fly, and it is more gentle in its movements, hence the cattle do not run or stampede wildly about when it is present. Furthermore the pasture fields of this country are becoming free of the old natural protection factors against this pest, as ponds of water, swamp areas, shrubs and trees. This is another reason why cattle run more now than they did twenty years ago. They cannot get away from the Warble Fly if the pasture field offers no protection, the trees have gone and the ponds have been drained, hence the cattle run around and around the enclosure until they are tired out. The name Heel Fly should not be used for either species, and it would be much better to speak of them both as Warble Flies or Hypoderma, if the confusion now existing in the minds of cattle owners is to be removed.

Flies other than Warble flies will cause cattle to run, so the Warble flies should not be held entirely responsible for all the unrest that is seen among cattle during the early and mid-pasture seasons.

The losses caused by the Warble Flies in Ontario can be listed as follows: Loss through damage to hides, loss through development of toxemic conditions in animals heavily infested, loss due to decrease in milk production, loss due to decrease in weight in beef cattle or feeders, loss due to animals becoming bogged or otherwise injured in their efforts to get away from the fly.

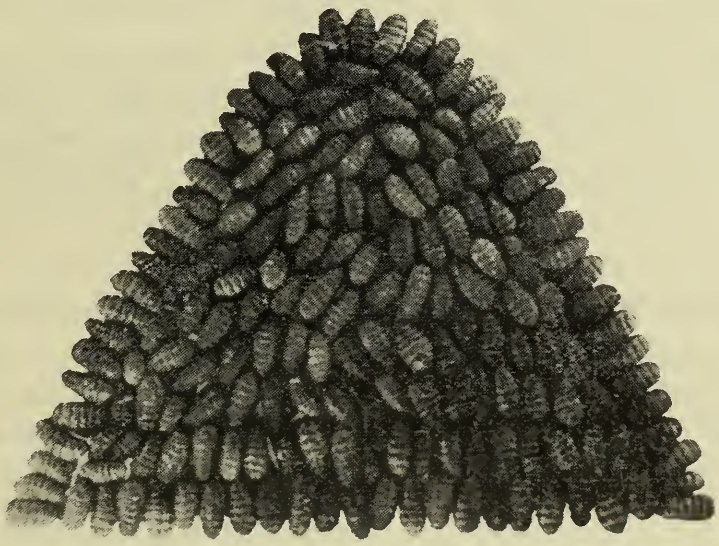
The great and needless loss that the Warble grubs cause to cattle hides that reach the tanneries and leather warehouses can only be appreciated by those stockmen that actually go to such places and inspect the hides both before and after the tanning process. The hide damage for Ontario has been estimated at over one million dollars each year. The best of the hide, that is, the section along the back, is spoiled and must be cut out after tanning as waste. It may be sold as glue stock at a low price per pound. More than five grub holes in a side of leather puts it into the number three grade. A grade that is not wanted by the manufacturers of military equipment, club bags, suit cases, belting and high-class harness. About 30 per cent. of the hides reaching the markets during the year are ''grubby'' at the time of delivery and about 60 per cent of all hides show some scar tissue areas where the grub holes have healed. This leather is weak, poor grained and does not wear well. Some Ontario tanners will not use hides from Canadian cattle, but import for their trade hides from those parts of the world in which the Warble flies are unknown (Australia, South Africa, New Zealand). This increases the cost to the consumer on all high-class leather goods used in Canada.

The loss through toxemia or an unhealthy condition of the animals that are infested with large numbers of grubs can be appreciated by cattle feeders when they notice that they are getting poor results from feed and labor bestowed on ''grubby backed'' animals. This loss is also noticed by those employees in the abattoirs whose duty it is to remove the hides from the slaughtered cattle or trim the backs of unsightly grub infested tissue that is always present on ''grubby'' cattle.

The loss due to a falling off in milk production during the ''gadding'' season has been noticed by every dairy farmer. Dairy cows can not milk, without first consuming adequate food and then ruminating in peace. So if milk cows spend part of the day in standing in ponds and swamps or gadding about the pasture field, a milk shrinkage is the inevitable result. Many dairy farmers keep their cows in darkened stables during the warm bright part of the day, in order that they may be out of the reach of the Warble flies. This means more work, more hand feeding of cows by the farmer, thus cutting down the profits and taking much time at a season of the year when crop production is of greatest importance.

The loss through decrease in weight in beef cattle is experienced by all feeders of cattle that follow a system of finishing on grass, or growing their young cattle principally on pasture. A frequent complaint coming from the open field grazing section of the province, where most of the beef cattle are finished, is ''my cattle gad around the pasture field all day and do not make weight on good grass,'' ''the Heel flies are after them, and around the field they go with their tails in the air,'' ''what can we do to keep the Heel flies away.'' The loss due to animals becoming bogged in swamps or injured through falling over embankments while stampeding, or jumping into water troughs or through windows, while not as great as the other losses, is a loss to be considered. It not only means a cut in the bank account, but it also shows the state of excitement that the presence of the Warble flies can develop in cattle.

The total loss in Ontario due to this pest is difficult to estimate, but it is believed to be over five million dollars each year. All of which is needless. Ontario cattle owners can do, if they will, as well as the Danish farmers have done. That is, reduce the loss until many districts are free of the costly pest.



170 Warble grubs were taken from the back of one cow. Needless to say this cow spent months in misery, and was unprofitable to her owner, while carrying this load of parasites. These grubs are known as fourth-stage larvae. They are one inch long.

THE WARBLE FLY (Hypoderma bovis)

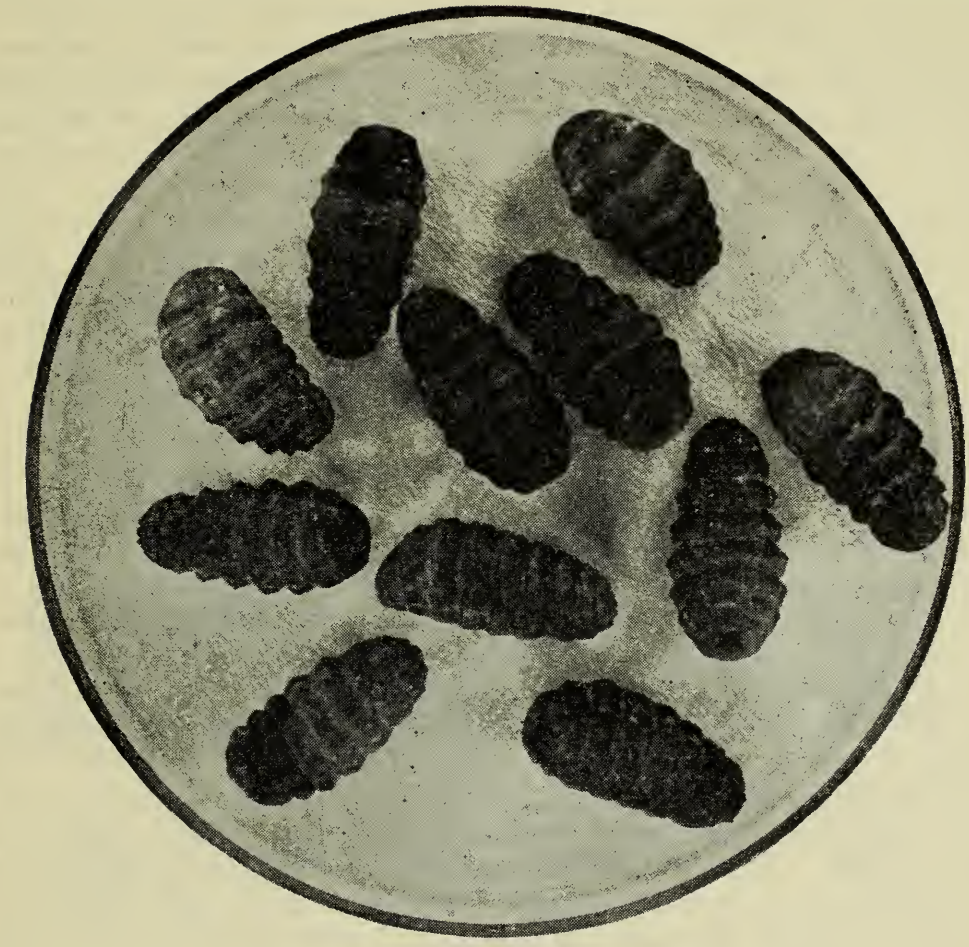
DESCRIPTION.—The Warble Fly is not a large insect; it is slightly over one-half inch in length; its colors are bright and varying, the under side of the abdomen is black, the thorax is yellowish, the posterior end of the abdomen is orange yellow in color, the legs are smooth and with very few hairs, the wing veins are dark brown and the alulae are ornamented with a reddish-brown border. The egg is a yellowish white in color.

The *Hypoderma bovis* is active during the bright part of the day. When approaching an animal with the intention of depositing its eggs, it strikes in an awkward, reckless way that usually frightens the animal and causes it to run. This Warble fly follows the running animal and usually succeeds in depositing its eggs. The eggs are deposited singly and the area most favored by this fly for this purpose is from the hock upward to a point midway to the hoofs and around to the escutcheon. Some eggs may be deposited along the flanks and forward to the shoulder. The non-scare individuals in the herd may receive the attentions of the egg-depositing fly while standing. The eggs are well concealed and not visible unless the hair is parted to expose them. Each female fly is capable of the production of 200 or more eggs, and when she succeeds in depositing these her life work is done, death follows. So the life period as a fly is comparatively short when compared with the long period of larval life, which is about eight months.

THE WARBLE FLY (Hypoderma lineatum)

DESCRIPTION.—This Warble Fly is slightly smaller than the Hypoderma bovis, being approximately one-half inch in length. The legs of the Hypoderma lineatum are rough and hairy. In this regard they differ very markedly from the smooth legs of the Hypoderma bovis. The wing veins are much darker in color than noted in the Hypoderma bovis and the alulae are white. The ventral surface of the thorax is black, as is also the anterior ventral surface of the abdomen. The posterior portion of the abdomen is a reddish orange in color.

The *Hypoderma lineatum* is active during the warm bright days of spring and on until the end of June. It starts its work of reproduction some six weeks earlier in the season than does the Hypoderma bovis. The Hypoderma lineatum is gentle in its movements when close to the animal and it does not frighten cattle that are used to being handled. Young cattle or cattle that are wild and nervous are likely to run on the approach of this fly. Quiet old cattle, in a recumbent position, will not bestir themselves when this fly approaches, but submit to its egg-laying activities. The Hypoderma lineatum will also deposit its eggs about the heels of standing cattle. It seems to prefer to work near the surface of the ground and usually selects a shadowy spot on the animal's body close to the ground on which to perform its egg laying. The flanks, udder, under surface of the abdomen, chest, brisket, fore and hind legs, parts that come in close contact with the ground while the animal is lying down are the areas on which the eggs may be found most abundantly. A number of eggs, yellowish white in color. cylindrical in outline and furnished with an attachment pedicle may be found attached to a single hair. The eggs are sometimes placed so as to be exposed and plainly visible. The female Hypoderma lineatum is capable of producing 200 or more eggs.



NATURAL SIZE.

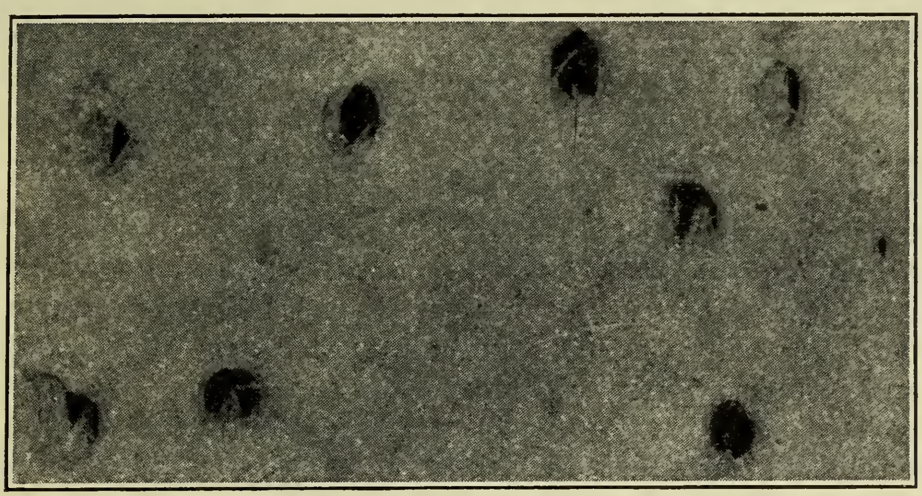
Warble grubs developed to the stage where they leave the animal. They are quite firm, dark brown in color, and sluggish in movement. When they reach the soil, they seek protection under the grass or soil debris, to pupate. The fully-developed fly emerges in about 30 days.

The Life History of the Hypoderma lineatum

The fertilized eggs of this Warble fly having been deposited on the hair of a cow or heifer or steer, usually a number in regular order on the single hairs that have been selected by the fly to receive and hold such, hatch in a period varying from four to eight days. Favorable weather conditions aid the incubation of the eggs and protect the young grub during the short time that it is exposed on the surface of the skin. The young larva after emerging from its egg case, crawls down the hair to the skin surface and at once proceeds to cut its way through. This skin puncturing process for those young grubs that succeed may take six hours. The thin-skinned young animal, and the thin-skinned areas on any cow or heifer, as the udder, the flank and back of the shoulder low down are more favorable to the entry of the young grub than is the thick tough skin covering the greater part of the animal's body. Many young larvae are halted in their efforts to puncture the skin by chilling in cold winds, by being washed off by rain, by being smothered with mud, by being killed when the cows are sprayed with fly repellant oils, and through not being strong enough to penetrate a tough skin. These perish, but enough get through to keep the pest going, to the detriment of the animal industry. Evidence of larva penetration can be seen by all who care to look for it in the hypodermal rash that follows the entry. This rash consists of a swelling at the point where the young grub entered and a crust formed from the serous exudate which collects due to the reaction of the tissues against the activity of the burrowing grub. The larvae that successfully penetrate the skin enter the connective tissue. Here they wander, if conditions are favorable to their development and progress, for six to eight months. Many perish or become lost in their wandering, but those that are destined to live eventually reach a position under the skin of the back. Just where the wanderings of the larva may take it is difficult to say. In the abattoirs where the Ontario grown cattle are slaughtered the young grubs or larvae are in the gullet in numbers after December the first and continue to be found in this area in numbers up to the end of March. A few are found during the period April to December, but the big run is over, and the great damage done to the oesophagus as sausage casing material is over by the end of March. Grubs begin to appear under the skin of the back in numbers in late December and continue until the end of July. A few are found during the period August to December in this same location. Grubs are more abundant under the skin of the back during the months of March and April in Ontario. The route taken by the young grub that enters at the brisket will show much variation from the route taken by the young grub that enters at the heel or coronet of a hind foot. On the slaughter floor of abattoirs in Ontario when carcasses are being split down through the vertebrae, exposing the spinal canal, the young larvae have been noticed in this position in late December. They are then about five-eights of an inch long, an ivory white in color and very active. From the spinal canal the larvae proceed to their final location under the skin of the back region. Here the young and active grub cuts a hole through the skin in preparation for further changes. The grub lies in the connective tissue with its ventral surface upward, the caudal end protruding into the freshly cut hole, which is oblique and conforms to the curve of the grub's outline, the grub lying, as it were, on its back. A reaction to the Warble grubs presence is set up by the surrounding tissues and a swelling occurs. Bacteria also get into the opening resulting in pus formation and the development of an area as sore as a boil. The Warble grub continues to grow and greatly increases in size during the six weeks or more that it spends under the skin of an animal's back. In this position the Warble grub passes the third and fourth stage of its development, becoming quite firm and sluggish in movement. When ready to leave the back of the host animal it is quite dark in color and the segments are well defined and armed with the exception of the segment in front of the spiracular segment. The opening in the skin enlarges sufficiently to permit the Warble grub to emerge when sufficient tension is put on the skin. This frequetly occurs when the animal bends its body in the act of licking the loin or tail-head areas, or in the acts of getting up or lying down. The Warble grub after emerging from the opening, rolls off the animal's back to fall to the ground. Here it may succeed in finding a cover suitable for its passing through the pupal stage. This is usually beneath grass or debris or in shallow surface dust. The transformation to the adult fly stage takes about thirty days from the time that the Warble grub left the back of an animal. When the newly released female fly emerges it seeks a mate in order that her eggs may be fertilized. This desire gratified, cattle on which to deposit the eggs are next sought, so that the next cycle of the Warble fly may commence again.

The Life History of the Hypoderma bovis

The life cycle of this Warble Fly is so similar to that of the Hypoderma lineatum just described that it need not be given separately. The larvae of both varieties go through the same cycle of development and are so much alike until they reach the fourth stage that they cannot be distinguished. The adult flies of both varieties show some marked differences in color markings, size, habits and effects on animals attacked. But the sum total of their destructive work is the same, that is, grubby hides, painful backs, licked beef condition, shrinkage in production and body injury.



Grub holes in a piece of tanned leather. The grub holes in the skin of a living animal will heal by filling in with scar tissue. Scar tissue will make the leather made from "grubby hides" weak, poor-grained, and rough.

What Others Have Done

The farmers of Denmark have made notable progress in reducing the losses due to Warble Flies in their country. Previous to 1923 the cattle owners of Denmark, although benefiting from educational propaganda on the elimination of the Warble Flies conducted by the Government, had not made the desired progress towards that end. So an Act was passed by the Danish Legislature in December, 1923, making it incumbent on every cattle owner to take measures for the extermination of Warble larvae appearing in his herd, and provided severe penalties for any cattle owner that refused to comply with the law. The success of the Danish law is shown in the following statement:

WARBLE INFESTED HIDES FOR THE ENTIRE YEAR (DENMARK)

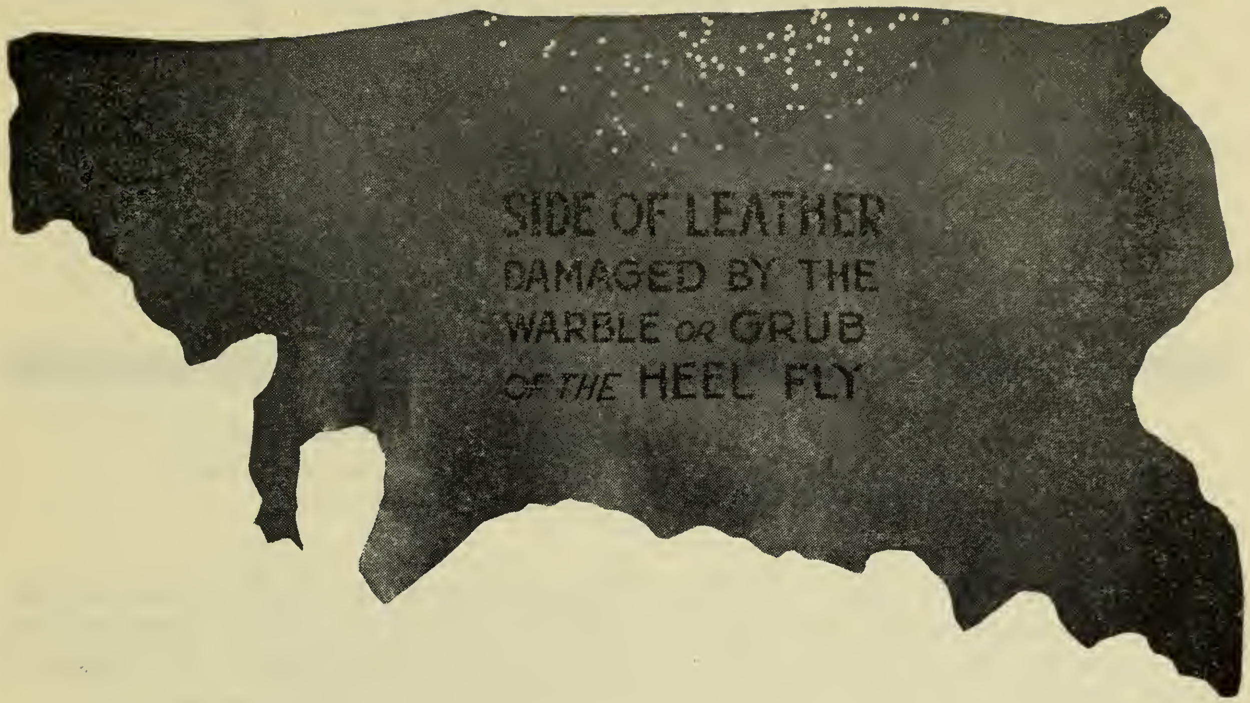
1922, the last year before the Act was in force	20½ per cent.
1923, the first year after the Act was in force	15 per cent.
1924, the second year after the Act was in force	4½ per cent.

This shows a progressive reduction in grubby hides, due to the killing of the Warble grubs. At the end of three years the legislation against the Warble Fly was considered so successful that it was renewed for a further three years, with the expectation of reducing the pest to the vanishing point. The enforcement of the law against cattle owners that neglected to destroy the Warble grubs brought results in Denmark for the simple reason that it caused all cattle to be treated. There are some cattle owners in nearly every district and in every country who, for reasons best known to themselves, neglect to do those things that are essential for the betterment of the animal industry at large. A law, the enforcement of which will cause the destruction of all the Warble grubs in every herd in a district, seems to be the only solution by which high efficiency can be attained in the elimination of this insect and thereby preventing the large annual losses now experienced. Everyone having charge of cattle must do his duty towards his cattle and his neighbor's cattle if the Warble pest is to be appreciably reduced in Ontario. It seems so easy, if everyone would do it, as all the Warble flies die after the egg laying is completed, leaving provision for the next generation of flies in the eggs they have left behind on the cattle. The grubs coming from these eggs, if they survive and have a successful trip through the connective tissues of the animal's body, appear under the skin on the backs of the cattle. They cannot survive elsewhere. They are all at the mercy of the cattle owner at this time, and if all were killed the pest would cease. As it is now one good cattleman will destroy the grubs in the backs of his cattle, but his neighbor neglects to do likewise with his. This neglect of one indifferent neighbor keeps the pest going. A group of farmers working together can attain worthwhile results by systematic treatment of all the cattle under their control, but complete success cannot be attained as Warble flies will come in from the untreated herds on the border of the district. Each pair of Warble grubs that get away and complete their development, or each female that flies in from surrounding herds, will provide much excitement for the cattle, and 200 eggs or more as a contribution to the continuance of the Warble pest. Kill every grub. Do it now. Get your neighbors to do likewise.

The Warble flies have been the subject of study for over one hundred years, and the investigations were undertaken with the view of finding ways and means to combat the pest and reduce the long recognized losses. In Canada Dr. Seymore Hadwen, while with the Federal Health of Animals Branch, did much to clear up the life history of the Warble flies and also awaken public opinion. In the United States Messrs. Schaupp, Cooper Curtice and Bishopp have done notable work. In Europe Bracey Clark, Hiurichen, Koorevaar, Carpenter and Glaser have been in the forefront in the Warble Fly investigational work.

The sum-total of the work on Warble flies done by the investigators mentioned in the previous paragraph, coupled with the result of effort by many other workers not here mentioned, has given to science and the animal industry sufficient information regarding the life and habits of the Warble flies to bring about their extinction if such knowledge were universally applied by cattle owners.

The experimental work carried out under the direction of the Committee on Warble Fly Pest of the Ministry of Agriculture and Fisheries of Great Britain proved the efficiency of dressings when applied to the warble areas on the backs of cattle. These dressings were composed of tobacco powder and lime, Derris root and water, Nicotine-Sulphate and lime and water, Iodoform and vaseline, and other drug and oil preparations. The experimental work of Bishopp and other entomologists working under the U. S. Bureau of Animal Industry have proven the efficiency of many drugs and preparations in the destruction of grubs and the practicability of their use.

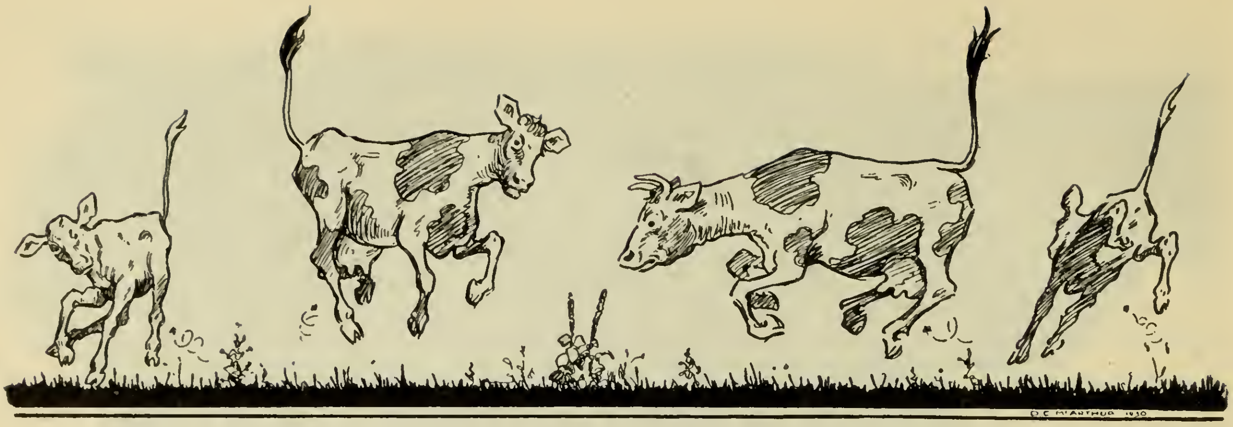


The small white spots are marked Warble grub holes. The best part of the side of leather is spoiled.

Control and Prevention

The Warble grubs do not all come up under the skin on the back of the animal at once. The presence of some may be felt in December or early January; others will come up in February, others in March, others in April, a few in May and June and an odd one during the other months. This factor of long-time infection of the cow's back makes the problem of treating more difficult. Young cattle turned away to pasture in the early spring may carry a few larvae that are still migrating. These are sure to escape and complete their life cycle. Hence the young cattle are frequently more grubby than the older milking cows that are within reach twice a day during the entire years.

For the stockman that is desirous of reducing the pest as much as possible under the existing conditions the following is suggested. Feel the backs of the cattle once each week from January on to the end of the grub season (July). When you locate, by feeling a small elevation, on the back of an animal, indicating that a grub has recently come up, remove the little scab and apply pressure. The young grub should pop out. Or you may inject a killing solution or ointment into the hole and kill the grub in its location. This will prevent its growing into a large grub and it will prevent the formation of a sore boil-like area. Don't wait until the grubs get quite large; get them when they first come up. Quick action will save the animal from the misery of the sore back condition that develops when the grubs are let grow to their full larval size. The squeezing of the Warble swellings after the young Warble has become encased in the hardening tissues which surround it will not be successful in removing the grub, but will cause the animal much pain and may result in abscess formation. The only time to squeeze a Warble swelling is when the grub first comes up, or else wait until it is fully developed and ready to come out easily. There is some danger to the practice of applying pressure to Warble grubs at any other time. Killing solutions or salves can be applied at any time, but the sooner the better for the comfort of the animal.



When cattle hear the Warble Fly their tails go up and away they go.
Dairy Cows go dry. Beef Cattle loose weight. Hides are spoiled.
Approximate loss in Ontario, $5,000,000 each year.

The following washes or Warble killing solutions have been found successful. All must be applied frequently enough to get all the grubs. Applications can be made with a cloth or brush directly to the warble area. Syringes and small squirt cans are also very useful in injecting the warble areas.

Tobacco Powder and Lime Dressing

Pulverized tobacco leaf	4 pounds
Lime	1 pound
Water	1 gallon

In a gallon of water mix one pound of lime; to this add four pounds of tobacco and allow the mixture to stand for 24 hours. Then strain the liquid through a piece of sacking. Apply the liquid to the warble areas with a cloth or brush or with a syringe. The liquid should be made to penetrate through the hole into the cavity of the warble.

Derris Powder and Water Dressing

Derris Powder	8 ounces
Water	1 gallon

Mix thoroughly, keep agitated and apply, preferably with a syringe, injecting a few drops in the hole into the cavity of the Warble. This mixture may also be applied with a small squirt can, or with a cloth or brush. It is necessary that the liquid enter the warble cavity to be effective.

Derris Powder and Vaseline Salve

Derris Powder	2 ounces
Vaseline	10 ounces

Mix thoroughly and apply by pressing a small piece in the hole into the warble cavity.

Iodoform and Vaseline Salve

Iodoform	1 ounce
Vaseline	10 ounces

Mix thoroughly and apply by pressing a small piece in the hole into the warble cavity.

Silver Nitrate and Water Dressing

Silver Nitrate	1 ounce
Water	20 ounces

Mix and apply by injecting with a syringe or squirt-can a few drops in the hole into the warble cavity.

Silver Nucleinate and Water Dressing

Silver Nucleinate	1 ounce
Water	10 ounces

Mix and apply by injecting with a syringe or small squirt-can a few drops in the hole into the warble cavity.

Argyrol and Water Dressing

Argyrol	1 ounce
Water	10 ounces

Mix and apply as with Silver Nucleinate Dressing.

Many other substances have been used with good success, and need not be mentioned here as those recommended are easy to get and easy to apply. All have high efficiency.

The grubs that are killed under the skin will, if young and not enclosed in the hard fourth stage casing, be absorbed and entirely disappear. The older harder grubs will shrink and be expelled or may be taken out.

Cows that are regularly sprayed twice each day during the fly season with evil-smelling mixtures, such as Birch Tar Oil, Pine Tar and Fish Oil, are not, as a rule, as heavily infested with Warble grubs as are the cattle that receive no fly repellant spray. Experiments to find ways and means to keep the Warble Flies away from the herd by the use of sprays have not been very successful. The most favorable reports show an improvement to be not over fifty per cent. less Warbles in the sprayed cattle.

This circular has been written for the cattle owner and not for the student. Those who may desire further information on Warble Flies may obtain such information from the following Government publications:

Dominion Department of Agriculture, Ottawa, Scientific Series No. 27.
Dominion Department of Agriculture, Ottawa, Scientific Series No. 22.
Report of the Ministry of Agriculture and Fisheries of Great Britain,

Committee on Warble Fly Pest, published by His Majesty's Stationary Office, Adastral House, Kingsway, London, W.C. 2, England. Price 1 shilling and 9 pence.

The Warble Flies by Bishop, Bureau of Entomology, U. S. Department of Agriculture, obtainable from the Superintendent of Documents, Washington, D.C., U.S.A. Price 50 cents.